"COMPARATIVE STUDY OF MANDIBULAR MORPHOLOGY IN PATIENTS WITH HYPODIVERGENT, HYPERDIVERGENT AND AVERAGE GROWTH PATTERNS"

A CEPHALOMETRIC STUDY

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In partial fulfillment of the requirements for the degree of

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BRANCH -V

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CERTIFICATE

This is to certify that **DR.SANTOSH REDDY.B,** *post graduate student(2008-2011) in the Department Of Orthodontics & Dentofacial orthopedics , J.K.K.Nataraja Dental College, Komarapalayam, Namakkal Dist – 638183, Tamilnadu. Has done the dissertation titled*

"COMPARATIVE STUDY OF MANDIBULAR MORPHOLOGY IN PATIENTS WITH HYPODIVERGENT, HYPERDIVERGENT AND AVERAGE GROWTH PATTERNS" A CEPHALOMETRIC STUDY

Under my direct guidance and supervision in the partial fulfillment of the regulations laid down by **THE TAMIL NADU DR.M.G.R MEDICAL UNIVERSITY, CHENNAI,** *for* M.D.S BRANCH – ORTHODONTICS & DENTOFACIAL ORTHOPEDICS DEGREE EXAMINATION.

It has not been submitted (partial or full) for the award of any other degree or diploma.

Dr.T.P.SWAMY. M.D.S,
Professor& Head,
Department of Orthodontics
J.K.K.Nataraja Dental College
Komarapalayam,
Namakkal Dist – 638183,
Tamilnadu

Dr.Siva Kumar, M.D.S,
Principal,
J.K.K.Nataraja Dental College
Komarapalayam
Namakkal Dist – 638183,
Tamilnadu

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INTRODUCTION

Craniofacial Biology is the study of the "development, growth and adaptation, both phylogenetically and ontogenetically, of the craniofacial skeleton and related structures"

The condylar cartilage acts as a regional adaptive growth site during mandibular growth. Absence of the condyles affects the amount of mandibular growth. Deviations in condylar growth can affect facial esthetics. Mechanical compression induces chondrogenesis and condylar growth. Masseteric resection in growing rats caused bradyauxesis of the mandibular condyles, indicating that occlusal force may also affect condylar growth. Occlusal force, maxillofacial morphology and mandibular condyle morphology seem to influence each other, but the relationship between occlusal force and mandibular condyle morphology has not been reported.

MANDIBULAR GROWTH

The mandible increases in size as a result of combined endochondral ossification and bone remodeling throughout its surface, particularly along its posterior border and buccal surface. Relative to itself (i.e., superimposed on stable structures within the mandible), the mandible increases in length, height and width as a result of expansion along its buccal surface and the entire posterior aspect of the ramus, i.e., the mandible grows upward and backward. Because it is attached to the rest of the cranium at its posterior-superior aspect, the temporomandibular joint, this upward and backward growth of the mandible is expressed as a downward and forward displacement relative to the cranium.

In this overall pattern, the growth of the mandible follows the growth of the midface. As the midface is translated downward and forward, the mandible keeps pace in the normally growing face. However, the relative rate and amount of growth of the maxilla and the mandible differ.

Geometrically, for every increment of maxillary growth, in a downward and forward direction, the mandible must grow significantly more if it is to keep pace with the midface.

The understanding of craniofacial growth is mandatory to diagnose the problem, to better understand the etiology of the problem and to evaluate the pre-treatment and post-treatment changes. When comprehensive understandings of these subjects are gained, favourable growth patterns will be identified and advantages will be taken from it. Unfavorable growth patterns must also be assessed because their treatment is more challenging.

The universally accepted orthodontic treatment goals of esthetics, health, function and stability must also be maintained in treating patients with hypodivergent and hyperdivergent growth pattern. Diagnosing a case with varied growth pattern requires a thorough understanding of growth, growth rotations and morphology of skeletal structures.

Facial growth relative to the cranial base line proceeds along a vector composed of variable amount of horizontal forward growth and vertical downward growth.

For normal occlusion and facial harmony, all bones should grow in harmony to each other. If a bone does not grow in harmony with the surrounding parts, some compensation of contiguous parts will usually occur for harmony, if not disharmony is evident.

Sites where major increases in bone size occur during facial growth include the sutures, the alveolar processes and the mandibular condyles. Consequently the growth of mandible plays an important role in the facial growth and development.

Mandibular growth changes are essentially recorded at four growth sites of mandible namely,

- Condyle and ramus
- Corpus
- Anterior alveolar process
- Posterior alveolar process.

Recently a great emphasis is placed on vertical dimensions of facial morphology. The vertical development is related to many skeletal units such as nasomaxillary complex, alveolar process and mandible.

The terms hypodivergent and hyperdivergent are used for describing the vertical growth patterns of face. If condylar growth is greater than vertical growth in the molar area, the mandible rotates counter-clockwise and results in a more horizontally directed growth of the chin and less increase in anterior facial height, extremes of this condition causing deep bites.

Conversely, if the vertical growth in the molar region is greater than that at the condyles, the mandible rotates clock-wise, resulting in more anterior facial height and less horizontal growth expression of the chin, tending to cause openbite.

The terms forward rotation & backward rotation, clockwise rotation & counterclockwise rotation are used to describe the rotations of mandible.

Additional factors that influence craniofacial growth and the resultant facial morphology includes – congenital defects , environmental defects at all stages of development, predisposing metabolic conditions and diseases, nutritional deficiencies and habits , altered muscle function as a result of tongue position , adenoid and tonsil size , breathing mode and tooth contacts in excursive mandibular positions.

Possibility of predicting the mandibular growth pattern by looking at specific anatomic mandibular structures.

On the lateral cephalogram seven structural signs seen for the identification of the mandibular growth rotation: [12]

(1) Inclination of the condylar head.

(2) Curvature of the mandibular canal.

(3) Shape of the lower border of the mandible.

(4) Inclination of the symphysis.

(5) Interincisal angle.

(6) Interpremolar or intermolar angle.

(7) Anterior lower face height.

In the past, various attempts have been made to assess the reliability of mandibular growth prediction using mandibular anatomic structures. Some authors could find an association between the mandibular morphology and the future growth direction.

The 'shape of the mandible' is often used by clinicians as an aid in predicting mandibular growth. Factors such as the size of the gonial angle, the inclination of the condyle, the depth of the antegonial notch, and the morphology of the symphyseal region have been associated by numerous investigators with the amount and direction of subsequent growth. However, most of these studies have used conventional cephalometric landmarks, which have limitations when researchers attempt to measure shape.

Structural signs of mandibular growth rotation are associated with hyperdivergent or hypodivergent skeletofacial morphology. Furthermore, age related changes in these structural signs have not been extensively studied.

In Dentofacial orthopedics a thorough knowledge of the skeletal and dental components that may contribute to a particular malocclusion is essential because these elements may influence the approach to treatment.

So, the present study attempts to relate hypodivergent, hyperdivergent average growth patterns and to determine alterations in mandibular morphology that occurs as a result of different vertical facial growth patterns in the local komarapalayam population.

There has been an interest in the multitude of differences in the diagnosis, treatment and treatment response between hyperdivergent, hypodivergent, and average facial types.

AIMS AND OBJECTIVES

The present study was undertaken with the following aims and objectives:

1. To evaluate the mandibular morphology in average growth pattern, hypo divergent growth pattern, and hyper divergent growth pattern.
2. To compare the mandibular morphology between

    a) Average and hypodivergent pattern

    b) Average and hyper divergent pattern

    c) Hyper divergent and hypo divergent patterns

REVIEW OF LITERATURE

William gillmore (1950)[1] conducted a study on 62 excellent occlusion cases and 67 class II cases in the age group of 16-42 years .The study concluded shorter mandible in class II there was no difference in cranial base length and gonial angle in both types of occlusions. Both occlusions maintained same relation with cranial base.

Ricketts (1960)[4] in his article he stressed the need for more understanding of the application of cephalometrics in treatment planning. A cephalometric procedure was thus shown to help establish the treatment goals for a particular case. Such terms as prediction, projection, prognosis, estimation, and cephalometric setup had come to be related to anticipation of the future behavior of an orthodontic case.

Garn, S.M. et al (1963)[5] their study had reported that, symphyseal thickness was probably independent of the major mass of muscle action although an exact mode of inheritance was not known. This study implied that the symphysis can be measured as a separate unit which develops independently from other morphological expressions in the same mandible.

Sassouni V, Nanda S (1964)[6] in their study Eight persons with skeletal deep bite and eight persons with skeletal open bite were followed longitudinally from age of 6 years to adulthood. In each type, the basic facial pattern was different. However, the intensity of expression of each trait composing the openbite and deep bite was less marked at 6 year level than adulthood. There were two significant differences with respect to the origin of the mechanism of open bite versus deep bite. The position of condyle was higher in open bite than in deep bite. The ramus was shorter in open bite than in deep bite.

F. F Schudy (1964)[7]Conducted a study to find out the relationship between the posterior and anterior facial height. Author introduced the term facial divergence, and the terms hyperdivergent and hypodivergent suggested as extreme facial divergence and he used SN-MP angle as a measure of facial divergence .Study concluded high angle cases showed low values for posterior to anterior height percentage.

Schudy FF (1965)[8] conducted a study to initiate the purpose of documenting the growth changes, which produced rotation of mandible and to identify specific increments of growth responsible. Study concluded, growth changes are interplay between vertical and anteroposterior growth directions and also concluded that there was a difference of 11mm in the nasion menton distance between retrognathic and prognathic type.

Creek more T.D. (1967)[9] conducted a study to document how the vertical growth was related to anterior and posterior growth. The untreated group consisted of 62 children with a mean age of 10-14 years, with a mean SN-MP angle of 33.77°. The treated group consisted of 50 patients, 18 males and 32 females, with SN-MP angle average of 31.57° Results showed that anteroposterior relation of maxilla to mandible decreased as the face matured. Rotation of the mandible was the result of difference in vertical growth at the condyle and total vertical growth in the molar region. Adaptability of the alveolar processes was the compensating element that maintained the stability of intercuspation.

Sassouni V, A(1969)[10] on classification of facial types showed that 4 basic facial types could be defined 2 in anteroposterior and 2 in vertical dimension. There were other syndromes which in addition created a facial deformity. Facial types were of multidimensional nature and are derived from the anteroposterior and vertical growth. Various bones interact intimately during growth, increasing or masking initial deformities.

Issacson JR, et al (1971)[13]conducted a study to examine the relationship between vertical parameters and mandibular rotation, and to examine extreme variations in facial growth. Lateral cephalograms of 183 patients with SN-MP angles greater than 38 degrees and of 60 patients with lesser than 26 degrees were selected and from these groups, 20 records were selected. Third group of 20 patients whose mandibular plane was recorded at 32 degrees were selected. Cephalometric tracings were done and results showed that high MP-SN angles resulted from relatively large amount of vertical alveolar growth, the vertical length of upper and lower molars as well as anterior dental height. As teeth or skeletal parts are located posteriorly, the MP-SN angle increased and with anterior positioning, the angle decreased.

Nahoum HI.(1975)[15] in his study the group with craniofacial malformations had slightly longer total facial height and palatal plane may be tipped upwards anteriorly so that upper anterior face height was shorter and lower anterior face height was longer. Posterior facial height was shorter than normal. An obtuse gonial angle was seen with a steep, notched mandibular plane. Dentoalveolar height was normal except for mandibular molar, which was significantly shorter.

Schendel SA, et al (1976)[16]carried out a study to distinguish between 2 groups of long face syndrome, with and without openbite. 31 patients of 17-25 years of age with vertical maxillary excess and typical dentofacial skeletal features of long face syndrome were included. 15 were openbite and 17 were non-openbite group. Cephalograms were used to measure linear and angular measurements. Mandibular plane angle and posterior facial height were greater in open bite group than non openbite group.

Issacson RJ, et al (1977)[17] conducted a study to demonstrate jaw rotations and to explain how those rotations occurred. The study concluded that when the vertical growth at the condylar- fossa area exceeded the vertical growth at the sutural–alveolar process area, forward rotation occurred. When the amount of vertical growth at the alveolar process was equal to the vertical growth at condyle, mandible had a parallel movement and when vertical growth at alveolar process exceeded the vertical growth at condyles, backward rotation occurred.

Isaacson R.J (1977)[18]carried out a study to determine whether the theory of archial growth of the mandible was clinically acceptable as a method of predicting mandibular morphology and size. 8 patients 6 girls, 2 boys were selected and for them gold implants were placed. Lateral cephalograms were taken and 6 year growth prediction using racial methods was done. The results stated that racial method appears valid for prediction of mandibular growth.

OpdebeeckH.1978)[20] studied Lateral cephalograms of 27 untreated adult Caucasians. Some linear and angular parameters were compared to the Bolton standards. The short face syndrome was a recognizable facial type with reduced lower face height, increased ramus height, posterior maxillary height, and reduced SN-MP angle, and also showed decreased gonial angle.

Opdebeeck H et al (1978)[21]conducted by tracing 27 lateral cephalograms of untreated adult Caucasians with reduced lower anterior face height and they were compared with 9 tracings of untreated adults of the same origin with increased lower anterior facial height. The linear and angular measurements used suggested that long face syndrome was attributed to clockwise rotation of mandible and short face syndrome attributed to counterclockwise rotion of mandible.

Haskell B.S (1979)[22]study suggested that chin increased in size as mandibular type varied from vertical type to horizontal type of growth pattern. With vertical development of the mandible, a smaller proportion of protruding chin was present. Chin increased in size as mandibular basal arch form varied from tapered in vertical cases to more square in horizontal cases.

R E Bibby (1979)[23] study on lateral ceph of 144 males, 124 females and study concluded that female cranial dimensions were smaller than the corresponding males.Craniofacial morphology in males and females appeared to be identical except in posterior facial height. Male skulls were 8.5% larger than female skulls.

SAMIR.E.BISHARA (1981)[24]examined the changes in mandibular dimensions and relationship as they related to standing height. Subjects consisted of 20 males and 15 females' ages between 8 and 17 years. Their study concluded

- The timing of mandibular changes in size and relationship were not correlated and not accurately predictable, to the changes in standing height.
- There were significant changes in mandibular morphology between 8 and 17 years
- The presently available methods of prediction did not accurately determine which individual will or will not have a pubertal spurt and for those few individuals who

might express one; it was still impossible to accurately estimate the timing as well as the magnitude of the change.

- The changes in mandibular relationship in the premaximum, and the maximum periods were of similar magnitudes clinically and statistically.
- The findings indicated that treatment of anteroposterior discrepancies should be started as soon as the orthodontist believes that it is indicated.

Fields HW et al (1984)[25]carried out study to describe vertical facial morphology and to identify morphologic factors associated with long face syndrome. 42 children of 6-12 years old and 42 young adults with varied vertical types were examined clinically and categorized into 3 vertical classifications- long, normal and short face. Lateral radiographs were taken, 7 angular, 18 linear and 6 ratio measurements were calculated. Results showed that for both long faced children and adults, anterior total face height, mandibular plane angle, gonial angle, and mandibulopalatal plane angle were significantly greater than normal. There was a tendency for long faced adults to have a short rami.

Vibeke Skieller, Arne Bjork (1984)[26]did a study for predicting the amount of growth rotation of the mandible on the basis of morphologic criteria observed on a single profile radiograph at pubertal age. Conducted study in sample size of 21 in whom actual mandibular growth rotation was determined from metallic implants over a 6 year period at around the time of puberty. Changes in molar inclination, shape of lower border of mandible and inclination of symphysis were observed. Intermolar angle tend to increase in forward rotation of mandible and decreased in backward. Convex shape of lower anterior border seen in forward rotators, and an almost linear shape of lower anterior border observed in backward rotators. Forward growth rotation of mandible was characterized by retroclination of symphysis irrespective of small or great mandibular inclination and backward growth rotation was characterized by proclination of symphysis and great inclination of mandible.

Henry w fields (1984)[27]conducted a study to

1) Describe facial morphology in long – normal and short faced children and long faced normal adults

2) Identified morphological factors associated with clinical evaluation of the long faced and normal subjects. Subjects for that study 42 children age of 6 to 12 years, 42 adults

Study concluded - Children with long face displayed steep mandibular plane, increased PP-MP angle, no difference in size of the ramus or body of the mandible, larger gonial angle.

Bishara et al (1985)[28] compared the dentofacial relationships of three normal facial types (long, average, and short) between 5 years and 25.5 years of age both longitudinally and cross-sectionally. The subjects consisted of 20 males and 15 females and found,

(1) There was a strong tendency to maintain the original facial type with age.

(2) Comparisons of the growth curves — with the exception of the incremental curves for MP: SN and Pog:NB in males

— Consistently demonstrated parallelism of the curves, regardless of the facial type.

(3) The persons within each facial type expressed a relatively large variation in the size and relationship of the various dentofacial structures.

(4) Significant differences in the dentofacial parameters were present between males and females with the same facial type.

(5) Longitudinal analysis of the data lend more consistent and therefore, more meaningful results than cross-sectional comparisons when facial growth trends needed to be evaluated.

Singer et al (1987)[29] 25 orthodontically treated patients with deep mandibular antegonial notch were compared with a similar group of 25 shallow notch subjects by the use of longitudinal lateral cephalometric radiographs. Deep notch cases had more retrusive mandibles with a shorter corpus, smaller ramus height, and a greater gonial angle than did shallow notch cases. The lower facial height in the subjects with a deep mandibular notch was found to be longer and both the mandibular plane angle and facial axis were more vertically directed. The results of this study suggested that the clinical presence of a deep mandibular antegonial notch was indicative of a diminished mandibular growth potential and a vertically directed mandibular growth pattern.

Rodney s lee (1987)[31] did a study on 21 implant subjects with extreme growth patterns against an alternative sample of 25 implant patients with less extreme facial patterns. Mandibular plane angle, intermolar angle, symphysis inclination, facial height index were used in this study. Study concluded that predicting future growth was highly successful in extreme cases than normal cases. He advised orthodontist must continue to rely more on clinical observations made during treatment than upon predictions made using pretreatment records.

Nanda (1988)[32]did a study to examine the patterns of facial growth development in subjects with skeletal open-bite and skeletal deep-bite faces. Longitudinal data based on lateral cephalometric radiographs of 16 male and 16 female subjects, ages 3 to 18 years, were used. It was established that the anterior dimensions of the face demonstrated divergent patterns of development in open and deep-bite faces. The posterior dimensions of the face did not discriminate between those two typological groups. The female open-bite subjects were earliest in the timing of the adolescent growth spurt, followed in succession by deep-bite female subjects, open-bite male subjects and finally the deep-bite male subjects.

P.A. Cook et al (1988)[33]The tracing errors associated with the structures used in Bjork's method of mandibular superimposition was investigated using multiple tracing of 50 lateral cephalometric radiographs. The horizontal error levels were much less than the vertical, midline structures more reliable than bilateral structures and the lower third molar tooth germ more reliable than the inferior dental canal.

Luc P.M. Tourne (1990)[35]Experimental evidence suggested that altered muscular function can influence craniofacial morphology. The switch from a nasal to an oronasal breathing pattern induces functional adaptations that included total anterior facial height and vertical development of the lower anterior face.

Halazonetis et al (1991) [36]A study was done to provide quantitative data at the period around the pubertal growth spurt and to test the hypothesis that early mandibular shape may influence the amount and direction of subsequent mandibular growth. Longitudinal data from lateral cephalograms were used. The shape of the mandible showed a slight difference between sexes and this difference increased after the pubertal growth spurt. Significant changes in mandibular shape during growth— especially after the pubertal growth spurt— resulted in more rounded mandibular outlines. The shape of the mandibular outline was moderately to highly correlated to the variables indicating mandibular and ramus inclination but poorly correlated to variables indicating anteroposterior jaw relationship

Tuomo kantomaa et al (1991)[37]Origin of condylar cartilage is not periosteal like that of other secondary cartilages; this cartilage originates from its own cellular blastema. Proliferation cells of the condylar cartilage are multipotential, they switch their differentiation pathway in the direction of osteoblasts in the absence of function and growth of cartilage ceases. This regulation of differentiation was mediated by maturation of cartilage cells. Cyclic AMP and Ca were important mediators in that process

Baumrind et al (1992)[38]did a study to evaluate the proportion of external chin in relation to symphyseal area in normal jaws and in those with diverse morphology was done. subjects were selected on the basis of normal growth, horizontal and vertical growth. Lateral and frontal radiographs were taken to analyze the general mandibular form and to determine the percentage of external / total symphyseal area. The mean displacement of gonion was in an upward and backward direction at an angle of approximately 45° to the Frankfort plane. Mean displacements at menton and pogonion were in a downward and backward direction but were very small. Mean displacement at point B was somewhat greater than that of menton and gonion, oriented in an upward and backward direction

Urban Hagg et al (1992)[39]In his study showed clearly that the mandibular growth was more pronounced when the scientific method (Bjork) was applied in comparison with the three standard cephalometric methods. Standard cephalometric methods did not express proportional estimates of the mandibular growth to those of the scientific method. Also the reliability estimate of mandibular growth by means of standard cephalometric method seems to decrease with age.

Aki T, Nanda et al (1994)[40] conducted a study to determine whether symphysis could be used as predictor of the direction of mandibular growth. Symphyseal dimensions studied were height, depth, ratio and angle. It was shown that symphysis morphology was associated with direction of mandibular growth. Mandible with anterior growth direction was associated with small height, large depth , small ratio and large angle of symphysis. Posterior growth ofmandible was associated with a large height, small depth, large ratio and decreased angle of symphysis.

Tor karlsen et al (1995)[41]Craniofacial growth was followed longitudinally in two groups of boys with low and high MP-SN angles. Group differences in dimensional changes were explained by a difference in matrix rotation of mandibular corpus, especially in the 6-12 year period. In the 12-15 year period, matrix rotation was similar in the two groups and so were dimensional changes. Morphologically, dimensional group differences in 6-12 year period were theoretically compatible with the fact that mandibular rotation was clearly more forward in the low angle than in the high angle group

Lambrechts, Harris et al (1996)[42]conducted a study to observe the dimensional differences in the craniofacial morphologies of groups with deep and shallow mandibular notching. 40 lateral cephalograms of untreated subjects with shallow mandibular notches and 40 subjects with deep notches. The study concluded that subjects with shallow mandibular notches revealed mandibular planes that were more horizontal, chins that were more prominent, shorter anterior facial heights, smaller gonial angles, shallower posterior ramus notch depths, and smaller occlusal plane inclinations than did deep antegonial notch subjects .

Clifford .p. singer (1996)[43] Conducted a study in 25 orthodontically treated deep

mandibular notches and compared with a similar group of 25 shallow notch group subjects. Study concluded that the lower facial height in the subjects with deep mandibular notches was found to be longer and mandibular plane angle was more vertically directed. Deep mandibular antegonial notch is an indication of diminished mandibular growth potential and a vertically directed mandibular growth potential.

Gail burke, Paul major et al(1998)[44] carried out study to determine the correlation between the condylar characteristics measured from pre-orthodontic tomograms of preadolescents and their facial morphologic characteristics. The study concluded that condylar head inclination and superior joint space proved to be the most significantly correlated condylar characteristics to facial morphology. Patients with vertical facial morphology displayed decreased superior joint spaces and posteriorly angled condyles, whereas, patients with horizontal facial morphology demonstrated increased superior joint space and anteriorly angled condyles.

Masahiro tsunori (1998)[45] did a study to evaluate the relationship between mandibular body tooth inclination, cortical bone thickness and facial types. Material for this study consisted 39 dry skulls, lateral cephalogram and 4 CT’s obtained for every skull. Study concluded that long face patterns included narrow arches because of narrow mandible and width of arches were smaller than short face subjects. Buccal Cortical bone thickness was greater in short faced subjects than long face.

Short face subjects showed flat mandibular plane, lesser gonial angle, long mandible and shorter lower anterior facial height.

Laurel R.leslie et al(1998)[46]conducted study to assess the method proposed by **Skieller,Bjork,and Linde- Hansen** in 1984 to predict mandibular growth, results were comparable to the Skieller value of 86%,and this method does not permit clinically useful predictions to be made in general population relative to the direction of future mandibular growth rotation

Andrew Girardot (2001.)[48]conducted a study to compare the condylar position in hypodivergent facial skeletal types, which concluded that the amount of condylar movement from the upward and forward position to the intercuspal position and it was measured. It was hypothesized that hyperdivergent group would exhibit greater condylar displacement than the hypodivergent group

A.B.M Rabie (2002)[49] designated a study to identify series of factors regulating condylar growth. Study conducted on 115 Sprague dawley rats, 35 days old. Immunostaining was used to identify those factors in protein level. Study concluded that Sox 9 factor which is expressed by cells in proliferative layer regulates condylar growth.

Ronald p. kolodziej, et al (2002)[50]Conducted a study to test the hypothesis that the antegonial notch depth was a useful predictor of facial growth. Study concluded that notch depth decreased a less horizontal growth was seen. Antegonial notch depth fails to sufficiently indicate future facial growth to warrant its application as growth predictor in non extreme population.

Julia von Bremen, Hans pancherz et al (2005)[51]conducted study to apply Bjorks structural signs of mandibular growth rotation to assess the hypodivergency or hyperdivergency of mandible. 135 lateral cephalograms of subjects were collected, out of which 95 subjects exhibited large and 40 subjects exhibited small mandibular plane angle. There was no association between the degree of hypo/ hyperdivergency or the age of the subject's .However hypodivergency was recognized more easily than hyperdivergency.

Herbert A klontz (2006)[52]The skeletal pattern of the high angle patient was generally a result of a multifactorial problem. Bjork stated that people who have long anterior facial heights were backward rotators. The indicators for these were straight condylar head, straight mandibular canal, notched inferior border of mandible, forwardly sloping mandibular symphysis.

Aya Kurusu; Mariko Horiuchi et al (2009)[53]did a study to clarify the relationship between occlusal force and mandibular condyle morphology using clinical data. The subjects were 40 female patients with malocclusion. The mandibular condyle morphology was assessed by using limited cone-beam CT imaging. The maximum occlusal force was calculated by using pressure-sensitive films. Moreover, condylar length was significantly correlated with the occlusal plane angle to the FH, the mandibular plane angle to the FH, the ramus inclination, and the posterior facial height (S-Go). Low-occlusal-force patients tends to have smaller mandibular condyles.

METHODOLOGY

For the present study, a sample of 60 randomly selected adult female patients with an age above 18 years were selected from department of Orthodontics, J.K.K. Nataraja dental college & hospital, Komarapalayam, Namakkal Dist . Ethical clearance was obtained from the institution.

Criteria for selection of patients;

- No severe craniofacial disorders
- No history of previous orthodontic treatment.
- No missing maxillary and mandibular first molar and anterior teeth.
- 60 patients in the age group range 18 years and above were selected.

Source of data:

The study was performed on the basis of standard lateral cephalograms of the patients and the cephalograms were traced. Cephalometric measurements were carried out manually using Bjork signs.

METHOD

Materials for radiographs:

Lateral cephalograms to evaluate the dentoskeletal features.

For exposing lateral cephalometric radiograph

8x10” Kodak film

8x10” cassette with Kodak intensifying screens

Digital cephalostat

CEPHALOMETRIC TECHNIQUE

Standardization and accuracy in relationship of the tube head to cephalostat were most important.

Standard lateral cephalograms were taken with the target film distance 17.14cm,

73 KVp, 15ma and 9.4 seconds exposure time.

Preparation of the patient-

Patient was instructed to remove all removable dental prosthesis and metallic objects such as glasses and jwellery from the head and neck region.

Patient stood with her face towards the front.

Ear plugs were inserted into the external auditory canals.

Localizer was switched on to position the patient's head according to the FH.

Localizer switched off after approx 100sec or as soon as the exposure started.

Patient head was tilted or raised until it was positioned correctly.

Adjusting the nose support –

The nose support was folded down.

Nose support was pushed to the nasal root.

The diaphragm and sensor move all the way to front and into the starting position for scanning

Exposure was released.

Exposure was made with the teeth in complete centric occlusion; the lips were in relaxed position.

TRACING - Equipment and material necessary for tracing included a view box, with variable light intensity; 0.003-inch thick trace acetate with one matte surface, a millimeter ruler; protractor, two draftsman's triangles and a well sharpened medium hard pencil. The matte acetate was customarily attached to the film with two small pieces of masking tape along one side.

Reduced room illumination helped in accurately locating the landmarks.

Accuracy and consistency in tracing technique was essential so tracing was always carried out by the same operator.

Method of collection of data: Sample consisted of randomly selected 60 adult female patient records, which included pre-treatment lateral cephalometric radiographs of all these patients.

According to Bjork Subjects were divided into 3 groups with regard to SN-GoGn angle.

- Hypodivergent group with SN-GoGn angle less than 28degrees.
- Average group with SN-GoGn angle between 28-32degrees.
- Hyperdivergent group with SN-GoGn angle greater than 32 degrees.

Bjork seven signs used in this study to evaluate mandibular morphology are:

- Inclination of condylar head
- Curvature of mandibular canal
- Shape of lower border of the mandible
- Inclination of symphysis
- Inter-incisal angle
- Inter-premolar or Inter-molar angles
- Anterior lower face height.

GLOSSARY OF LANDMARKS USED IN THIS STUDY

POINTS USED IN THIS STUDY (Fig 1)

Anterior Nasal Spine [ANS] [55]: point ANS is the tip of the bony anterior nasal spine as seen the lateral cephalogram.

Anterior convex point (ACP) [50] **-** point of greatest convexity along the anterior- inferior border of mandible

Gonion [Go] [55]: a constructed point, the intersection of lines tangent to the posterior margin of the ascending ramus and the mandibular base.

Inferior gonion (IGo) [50] – point of greatest convexity along the posterior – inferior border of the mandible

Menton [Me] [55]: is the most inferior point on the outline of the symphysis as seen on the lateral cephalogram.

Orbitale [Or] [55]: most inferior on the infra – orbital margin

Pogonion [Pog] [55]: most anterior point on the bony chin as seen on the lateral cephalogram.

Point B [Supramentale] [55]: It is the most posterior point in the outer contour of the mandibular alveolar process.

Porion [Po] [55]: 'anatomic porion' is the outer upper margin of the external auditory canal, Machine porion'' is the upper most point on the outline of the metal rings on the ear rods of the cephalostat.

POINTS USED IN THIS STUDY

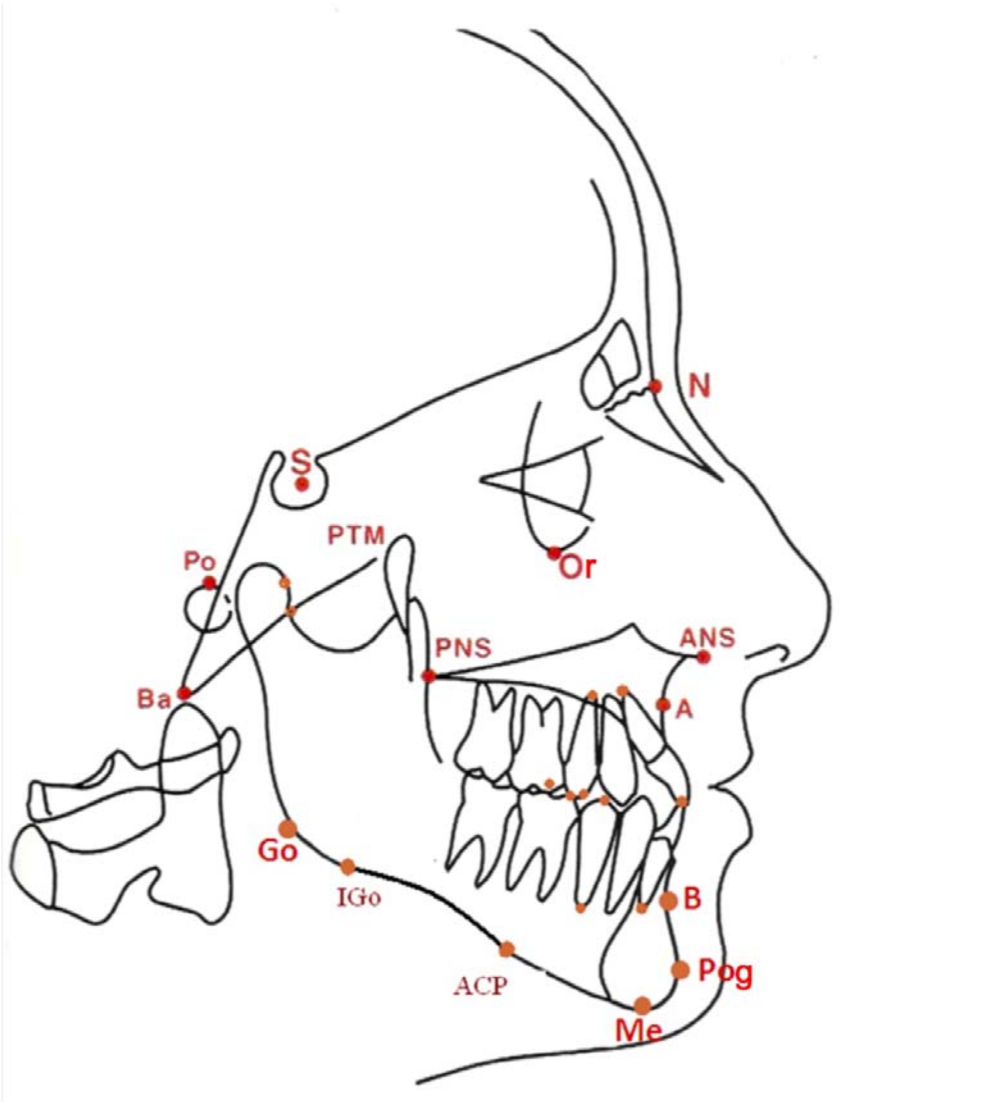


Fig - 1

PLANES USED IN THIS STUDY (Fig 2)

1) **S-N plane** [56]**–** Sella – nasion anteroposterior extent of anterior cranial base

2) **SN marked (SN')**[41] – sagittal axis was constructed through at an angle of 8° to t he SN line

3) **Frankfort horizontal plane [FH]** [56]**:** A line connecting point's porion to Orbitale.

4) **Palatal plane [ANS-PNS]** [56]**:** A line connecting the anterior nasal spine of the maxilla and posterior nasal spine of the palatine bone.

5) **Mandibular plane [MP]** [56]**:** A line connecting points Gonion and menton.

6) **Chin tangent line (CTL)** [26] **–** line connects Pog and point B

PLANES USED IN THIS STUDY

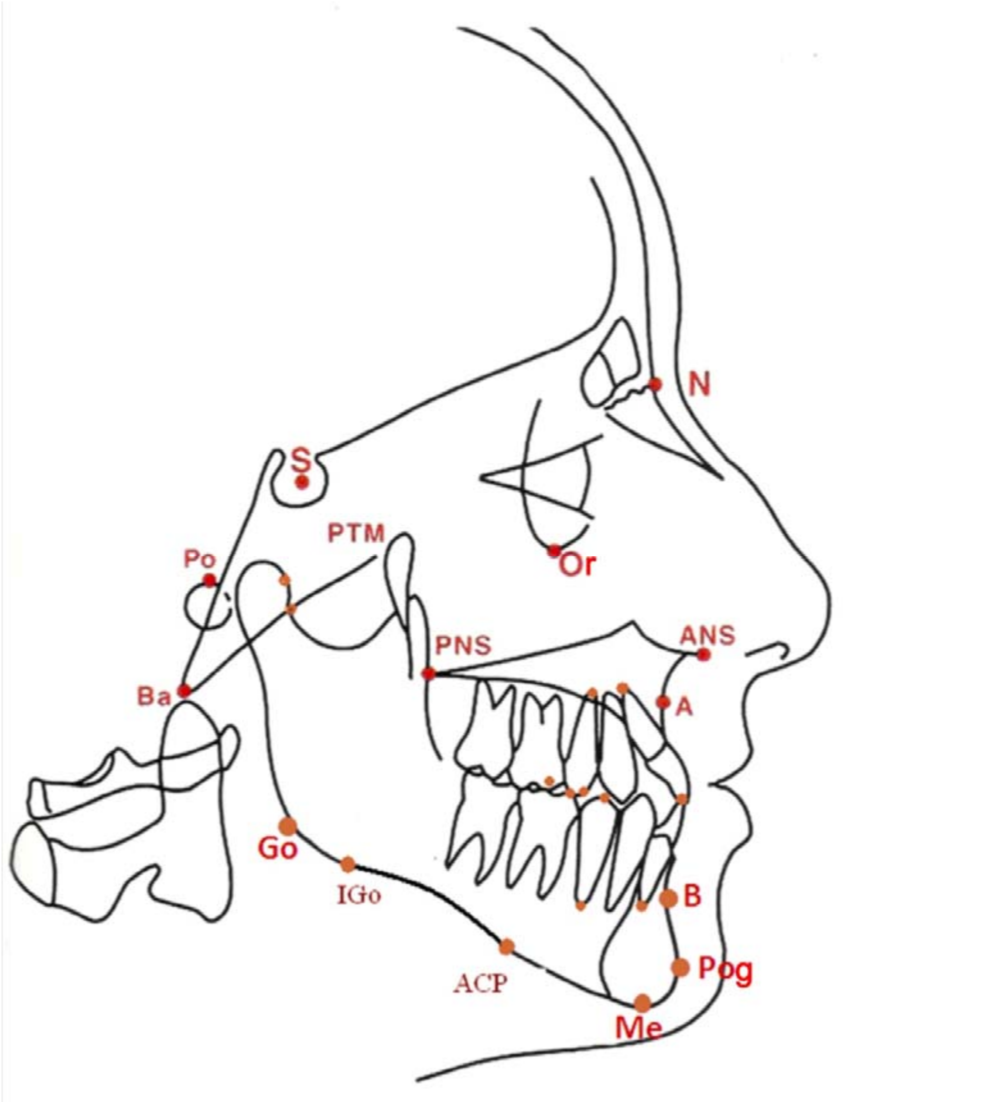


Fig 2

1) SN plane **2) SN' (SN marked)** **3) FH plane**

4) Palatal plane **5) Mandibular plane** **6) Chin tangent line**

ANGULAR MEASUREMENTS USED IN THIS STUDY (Fig 3)

1) **Condylar head inclination[44] –**Angle between lines represent anterior cant of the condylar head and line perpendicular to Frankfort horizontal plane.

2) **Symphysis inclination[26] –** Angle between chin line and SN plane

3) **Inter molar angle (IMA):** A vertical line drawn from the mesiobuccal cusp of upper first molar to the palatal plane and connecting the line joining the mesiobuccal cusp of lower first molar to the mandibular plane.

4) **Inter premolar angle (IPA)** Angle between long axis of upper and lower 2nd pre molar

5) **Inter incisal angle (IIA) [56]:** A line drawn through the long axis of the upper central incisor and the lower central incisor. The intersecting angle was taken.

6) **Mandibular plane angle (SN-**MP) – Angle formed between the SN plane to MP plane

ANGULAR MEASUREMENTS USED IN THIS STUDY (Fig 3)

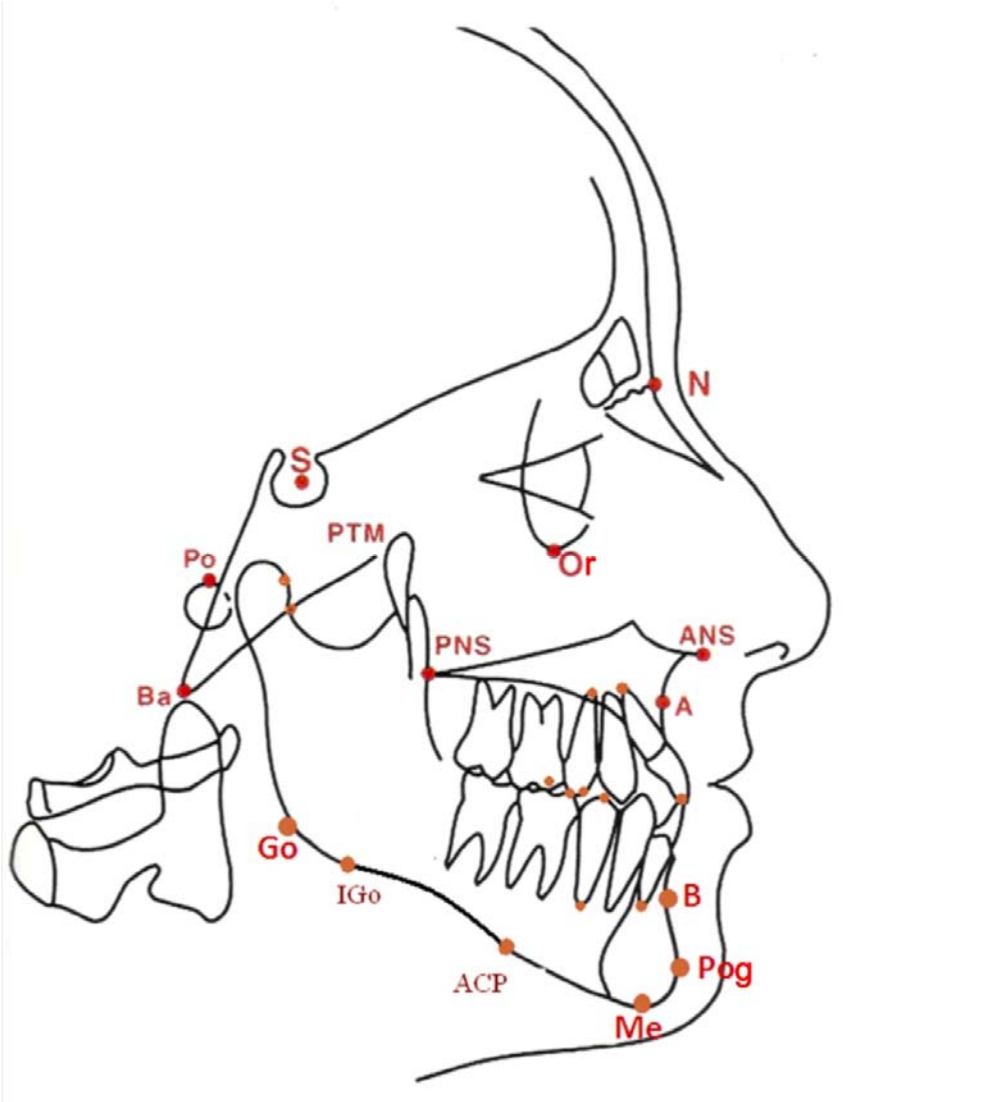


Fig 3

1) **Condylar inclination** **2)symphysis inclination**

3) Intermolar angle **4) Interpremolar angle**

5) Inter incisal angle

LINEAR MEASUREMENTS USED IN THIS STUDY (Fig 4)

Ante gonial notch[50]: antegonial notch depth as measured from greatest point of convexity in antegonial notch to line connecting anterior convex point with inferior gonion.[50]

B-Pog sag[41] – sagittal distance between B-point and pogonion on to SN marked. An expression of the inclination of the symphysis

Anterior lower facial height (ALFH) – distance measured from ANS and Me

LINEAR MEASUREMENTS USED IN THIS STUDY

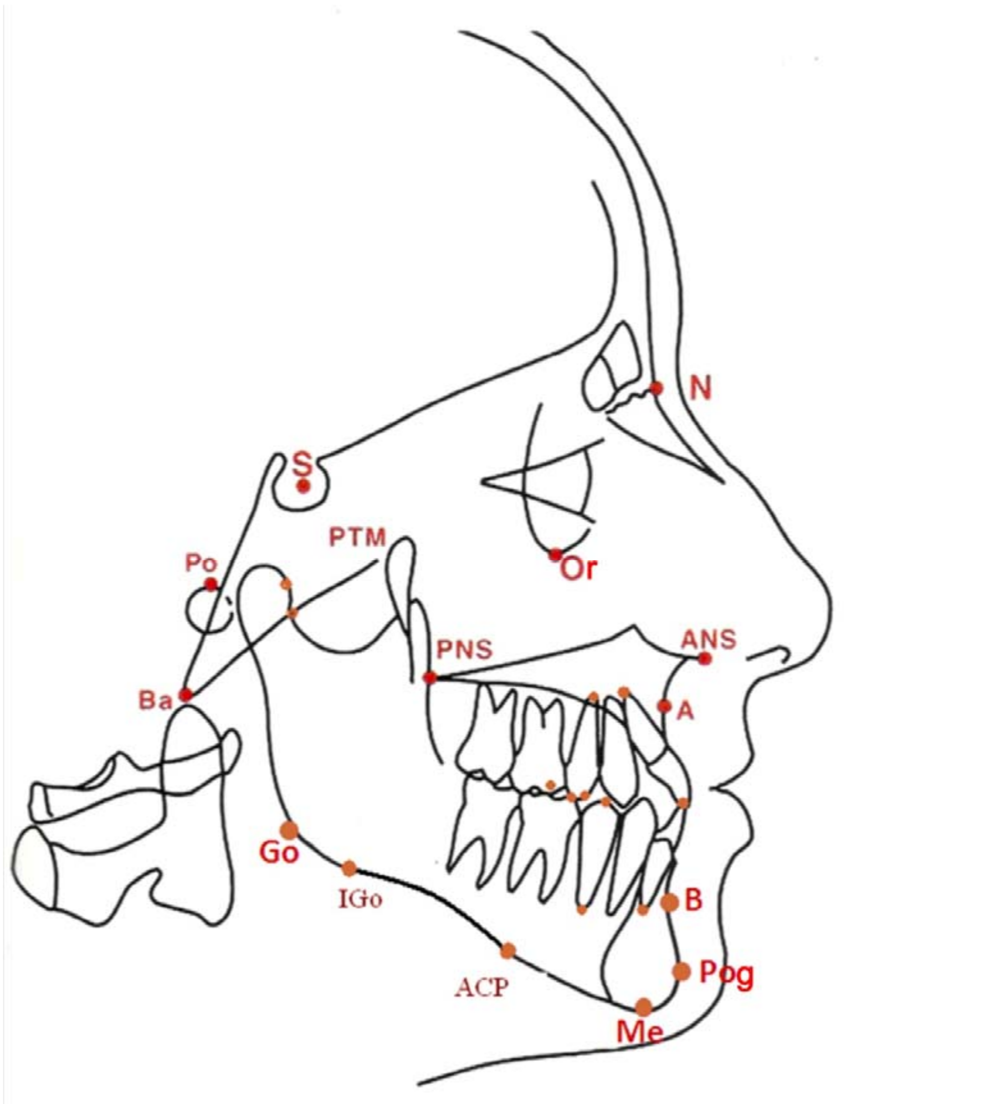


Fig 4

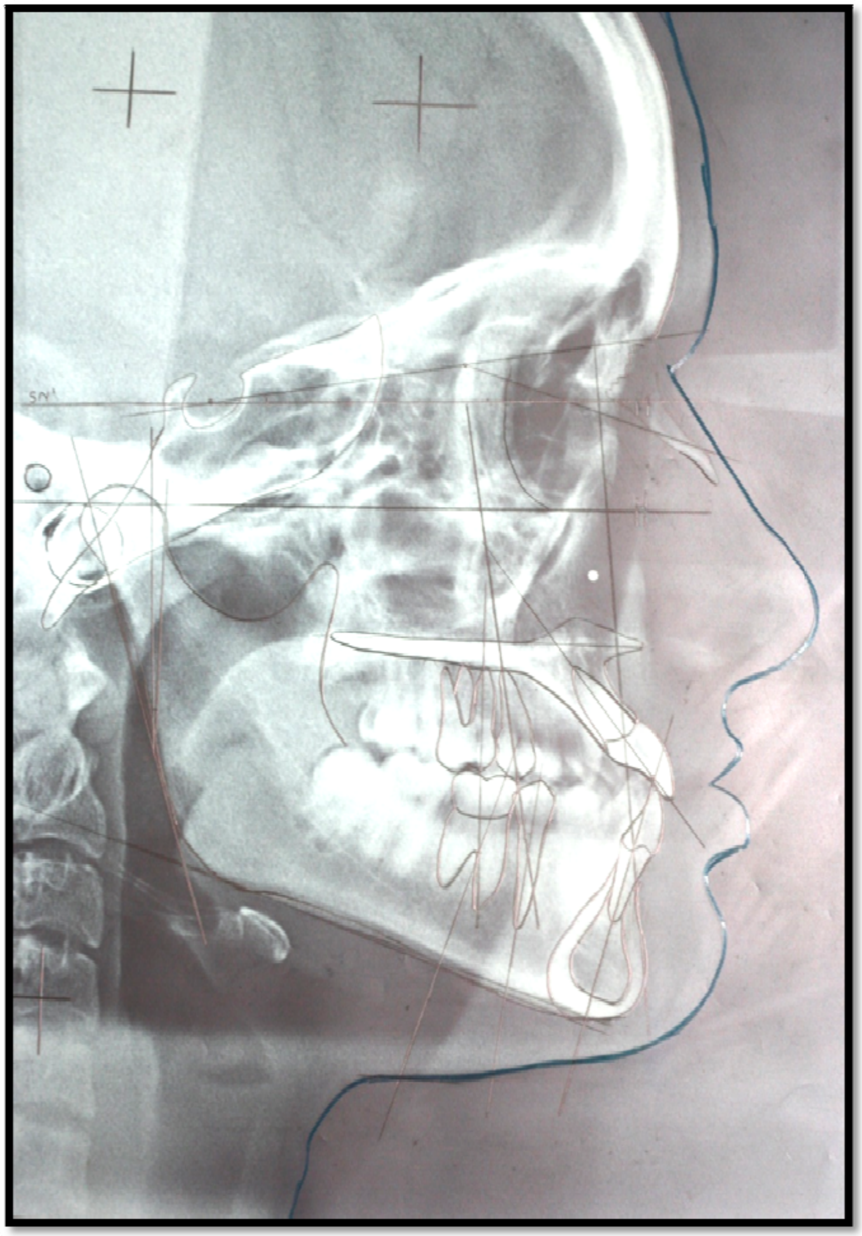
1) Antegonial notch depth

2) B-Pog sagittal

3) Anterior lower facial height

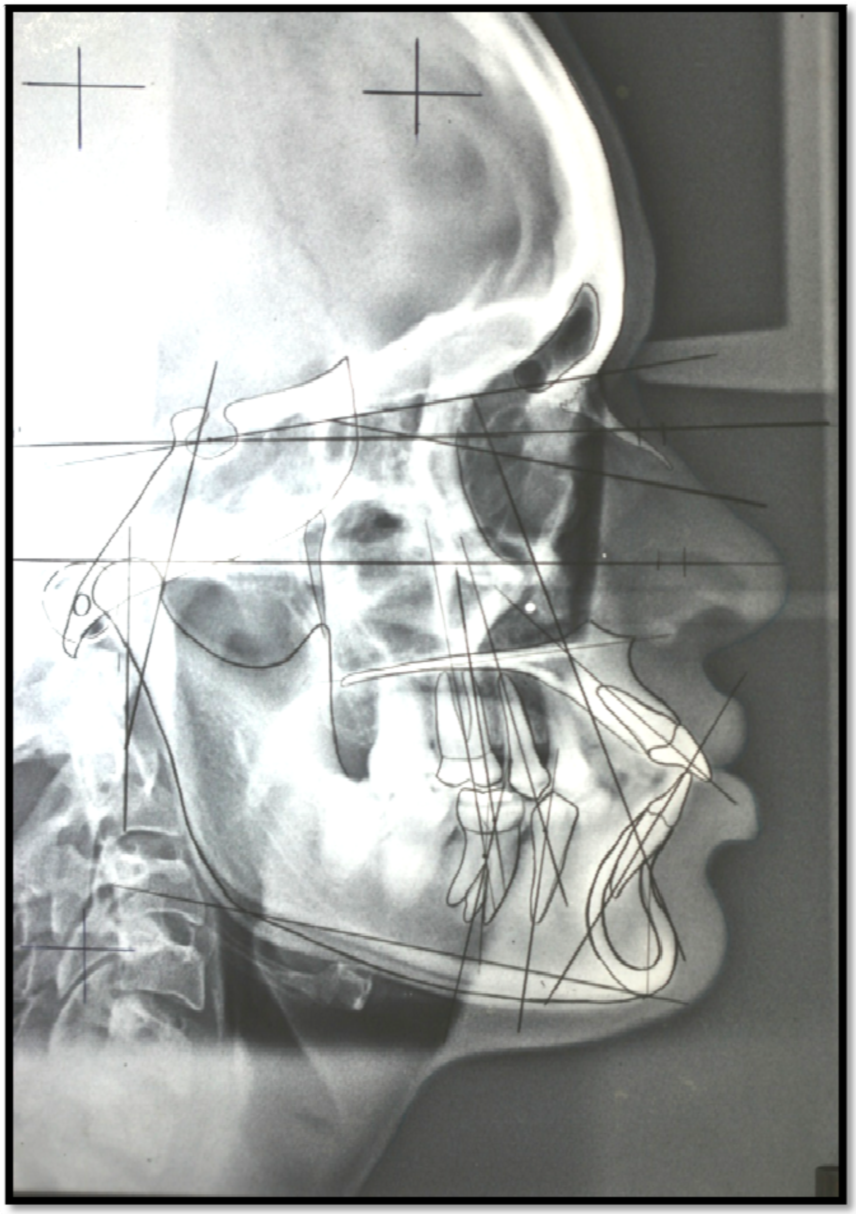
COLOUR PLATES

AVARAGE GROWTH PATTERN WITH TRACING



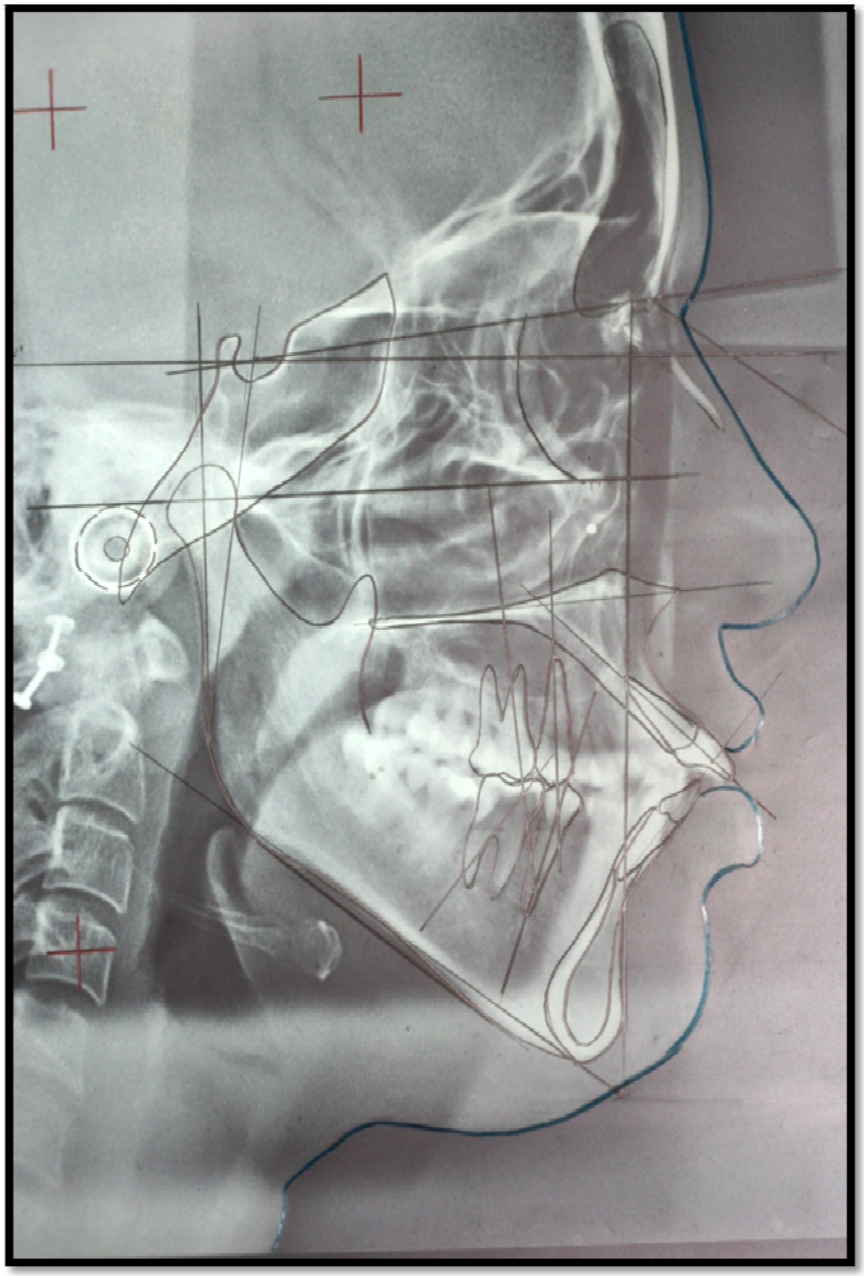
COLOUR PLATE NO-1

HYPODIVERGENT GROWTH PATTERN WITH TRACING



COLOUR PLATE NO - 2

HYPER DIVERGENT GROWTH PATTERN WITH TRACING



COLOUR PLATE NO - 3

ORTHOPHOS XG 5DS/CE

COLOUR PLATE NO - 4

PATIENT IN SITU

COLOUR PLATE NO -5

PATIENT POSITIONING

FRONT VIEW

PROFILE VIEW

HYPODIVERGENT GROWTH PATTERN

SL NO	NAME	MP GO-ME	INCLINATIN OF CONDYLAR HEAD	ANTE GONIAL NOTCH	SYMPHYSIS INCLINATIO N	INTER INCISAL ANGLE	INTER MOL AR ANGL E	INTER PRE MOLAR ANGLE	ALFH
1	GOPIKA	27°	8°	1mm	89°,2mm	120°	162°	173°	69mm
2	BANU PRIYA	27°	9°	1mm	90°,3mm	108°	157°	160°	68mm
3	RAJESHWARI	23°	7°	0mm	97°,5mm	90°	155°	159°	67mm
4	HARI PRIYA	20°	10°	0mm	115°,3mm	94°	166°	160°	58mm
5	MUMTHA	24°	9°	0mm	98°,6mm	104°	166°	171°	68mm
6	RAMYA	26°	13°	1.5mm	94°,5mm	109°	157°	174°	74mm
7	NIVETA	27°	9	2mm	94°,4mm	112°	160°	170°	66mm
8	SUJITHA	25°	12°	0mm	87°,3mm	132°	165°	166°	68mm
9	HEMA LATHA	25°	17°	1mm	95°,3mm	120°	160°	175°	69mm
10	POONZH LAALI	22°	17°	0mm	98°,4.5mm	125	166	169°	64mm
11	THIRUMALAR	18°	7°	0mm	105°,5.5mm	117°	164°	166°	61mm
12	ASHWINYA	27°	10°	2mm	84°,1mm	109°	160°	165°	70mm
13	PRIYA	27°	14°	2mm	86°,2mm	128°	163°	164°	66mm
14	SALINI	24°	17°	2mm	94°,4mm	116°	164°	171°	57mm
15	RAJESHWARI	21°	13°	3mm	100°,4.5mm	103°	160°	157°	65mm
16	SANGEETA	26°	12°	0mm	85°,2mm	113°	165°	173°	62mm
17	RETHIKA	27°	8°	2.5mm	89°,2mm	102°	152°	170°	77mm
18	KOWSALYA	25°	13°	1mm	95°,3mm	120°	160°	171°	68mm
19	PRIYA	24°	9°	0mm	98°4mm	104°	166°	175°	68mm
20	HAMSA	27°	14°	2mm	90°,3mm	109°	166°	165°	70mm

AVERAGE GROWTH PATTERN

SL NO	NAME	MP (GO-ME)	INCLINATIN OF CONDYLAR HEAD	ANTE GONIAL NOTCH	SYMPHYSIS INCLINATION	INTER INCISAL ANGLE	INTER MOLAR ANGLE	INTER PRE MOLAR ANGLE	ALFH
1	SARANYA	30°	8°	2mm	81°,1mm	86°	160°	161°	63mm
2	KIRUTHIGA	29°	18°	2mm	91°,2.5mm	133°	160°	161°	57mm
3	SWATHI	30°	7°	2mm	89°,2mm	130°	157°	166°	74mm
4	ABIRAMI	30°	9°	1mm	78°,1mm	103°	155°	167°	69mm
5	PRIYANGA	31°	11°	0mm	88°,2mm	114°	154°	162°	69mm
6	PRAVEENA	32°	12°	1mm	85°,1mm	95°	153°	159°	65mm
7	PRABA	31°	8°	0mm	75°,1mm	108°	160°	158°	70mm
8	AARTHI	29°	8°	2mm	90°,2mm	104°	159°	165°	64mm
9	MAHA LAKSHMI	32°	7°	1mm	96°,4mm	103°	152°	168°	61mm
10	SALINI	30°	10°	1mm	93°,3mm	112°	158°	163°	70mm
11	PADMINI	32°	7°	2mm	78°,0mm	107°	159°	162°	66mm
12	FOUZIA	31°	5°	2mm	84°,1mm	110°	159°	176°	59mm
13	ANU BARATHI	29°	5°	1mm	88°,2mm	124°	156°	162°	65mm
14	POOVJA	32°	5°	1mm	82°,2mm	113°	155°	155°	82mm
15	SELVA NAYAKI	29°	5°	2mm	70°,-2mm	104°	162°	165°	65mm
16	RAMYA	30°	6°	1mm	83°,1mm	118°	156°	162°	72mm
17	KALAI VANI	32°	6°	1mm	84°,2mm	117°	157°	162°	70mm
18	MOHANA BIHAM	31°	6°	1mm	84°,0mm	109°	163°	163°	71mm
19	NIRMALA	31°	8°	1mm	79°,1mm	104°	155°	170°	67mm
20	SHAILA	29°	7°	0mm	85°,1mm	105°	158°	170°	68mm

HYPERDIVERGENT GROWTH PATTERN

SL NO	NAME	MP (GO-ME)	INCLINATIN OF CONDYLAR HEAD	ANTE GONIAL NOTCH	SYMPHYSIS INCLINATION	INTER INCISAL ANGLE	INTER MOLAR ANGLE	INTER PRE MOLAR ANGLE	ALFH
1	DIVYA BHARATHI	43°	6°	1.5mm	77°,1mm	120°	142°	159°	89mm
2	KRISHNA VENI	36°	4°	0mm	87°,0mm	123°	149°	155°	79mm
3	VISHNAVI	34°	8°	2mm	68°,-3mm	97°	154°	154°	64mm
4	VIKASHINI	42°	6°	2.5mm	74°,1mm	108°	144°	160°	75mm
5	SHARMILA	40°	2°	2.5mm	80°,1mm	87°	148°	162°	73mm
6	AMBIKA	35°	5°	2mm	76°,-1mm	95°	152°	176°	55mm
7	PUNITHA	38°	4°	1mm	77°,0mm	108°	149°	154°	80mm
8	SARNYA	36°	5°	2mm	85°,1mm	109°	152°	140°	70mm
9	DEVIKA	36°	5°	1.5mm	80°,0mm	87°	159°	157°	72mm
10	RAMYA	42°	7°	3mm	67°,-1mm	104°	145°	147°	77mm
11	SABARI	33°	10°	3.5mm	85°,2.5mm	130°	160°	160°	72mm
12	LIJITHA	35°	5°	0mm	71°,-2mm	109°	145°	160°	76mm
13	LEEMA	39°	6°	1mm	80°,0mm	97°	145°	160°	71mm
14	NITHYA	37°	14°	0mm	85°,2mm	115°	152°	157°	67mm
15	KALAMANI	43°	8°	0mm	80°,0.5mm	95°	136°	160°	87mm
16	DEVAKI	41°	3°	2mm	78°,1mm	109°	150°	170°	71mm
17	MUTHU LAKSHMI	37°	6°	1mm	84°,0mm	95°	144°	156°	85mm
18	MENAKA	40°	8°	2mm	76°,0mm	82°	146°	168°	73mm
19	RAJANI	36°	5°	0mm	90°,2mm	120°	148°	166°	72mm
20	KIRUTHIGA	42°	6°	2mm	92°,2mm	108°	145°	168°	75mm

STATISTICAL ANALYSIS

NULL HYPOTHESIS: There was no significant difference in the mean values of the three groups i.e. $\mu_1 = \mu_2 = \mu_3$

ALTERNATE HYPOTHESIS: There was a significant difference in the mean values of the three groups i.e. $\mu_1 \neq \mu_2 \neq \mu_3$

LEVEL OF SIGNIFICANCE: α=0.05

STATISTICAL TECHNIQUE USED: Analysis of Variance (ANOVA).

DECISION CRITERION: The decision criterion was to reject the null hypothesis if the p-value was less than 0.05 otherwise we accepted the null hypothesis.

If there was a significant difference between the groups, we carried out multiple comparisons (post-hoc test) using Bonferroni test.

COMPUTATIONS: The following tables gave us the results from ANOVA and the P-Value.

ANALYSIS OF MANDIBULAR PLANE ANGLE (SN – MP(GO-ME):

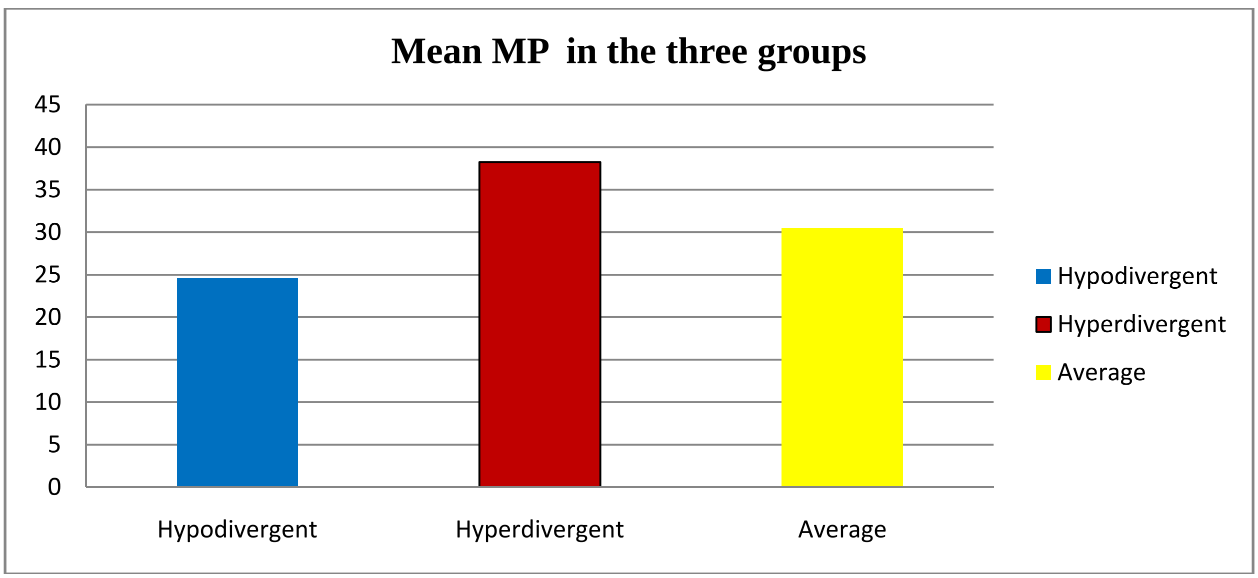
TABLE -1

Group	Mean	Std dev	Min	Max	F	P-Value	Significantly different from
i)Hypodivergent	24.60°	2.64°	18°	27°	152.845	<0.001*	ii, iii
ii)Hyperdivergent	38.25°	3.18°	33°	43°			i, iii
iii)Average	30.50°	1.15°	29°	32°			ii, iii

*denotes significant difference

Higher mean MP (GO-ME) was observed in hyperdivergent group followed by average and hypodivergent group respectively. The difference in mean MP (GO-ME) between the three groups was found to be statistically significant (P<0.001). The difference in mean MP (GO-ME) between hypodivergent and hyperdivergent group as well as between hypodivergent & average group is found to be statistically significant. Also, the difference in mean MP (GO-ME) between hyperdivergent and average group was also found to be statistically significant.

GRAPH - 1



ANALYSIS OF CONDYLAR INCLINATION:

(Note: Kruskal-Wallis test has been used here as the data did not follow normal distribution)

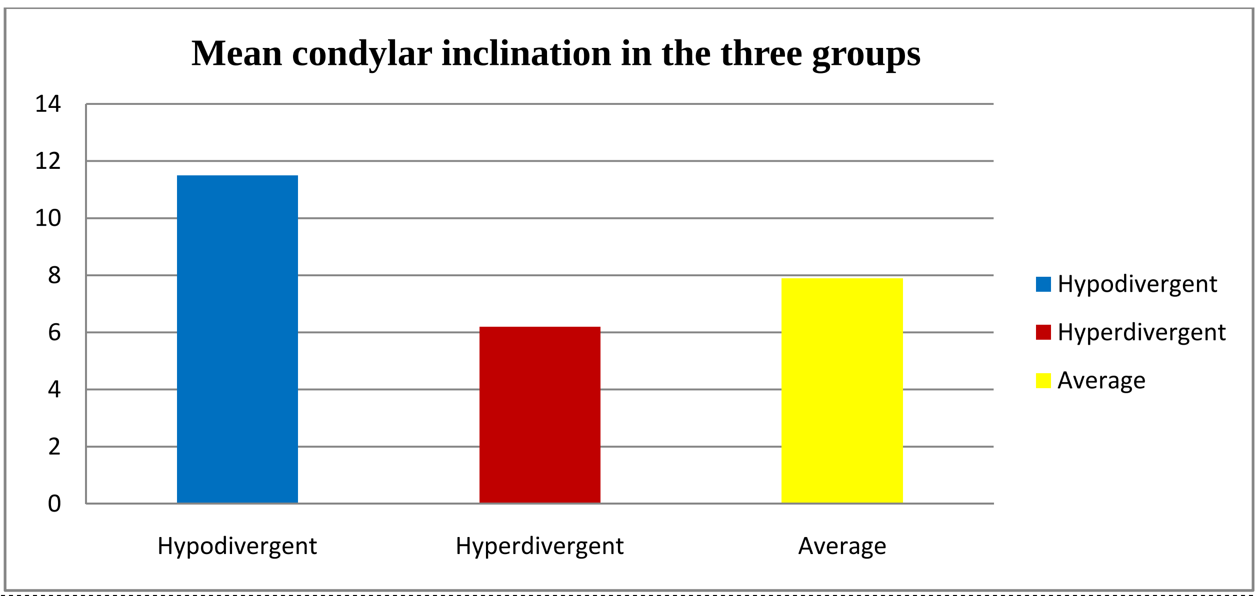
TABLE - 2

Group	Mean	Std dev	Min	Max	Kruskal-Wallis Chi-sq	P-Value	Significantly different from
(i) Hypodivergent	11.50°	3.03°	7°	17°	25.182	<0.001*	ii, iii
(ii)Hyperdivergent	6.20°	2.63°	2°	14°			i, iii
(iii) Average	7.90°	3.09°	5°	18°			ii, iii

*denotes significant difference

Higher mean condylar inclination was observed in hypodivergent group followed by average and hyperdivergent group respectively. The difference in mean condylar inclination between the three groups was found to be statistically significant (P<0.001). The difference in mean condylar inclination between hypodivergent and hyperdivergent group as well as between hypodivergent & average group was found to be statistically significant. Also, the difference in mean condylar inclination between hyperdivergent and average group was also found to be statistically significant.

GRAPH - 2



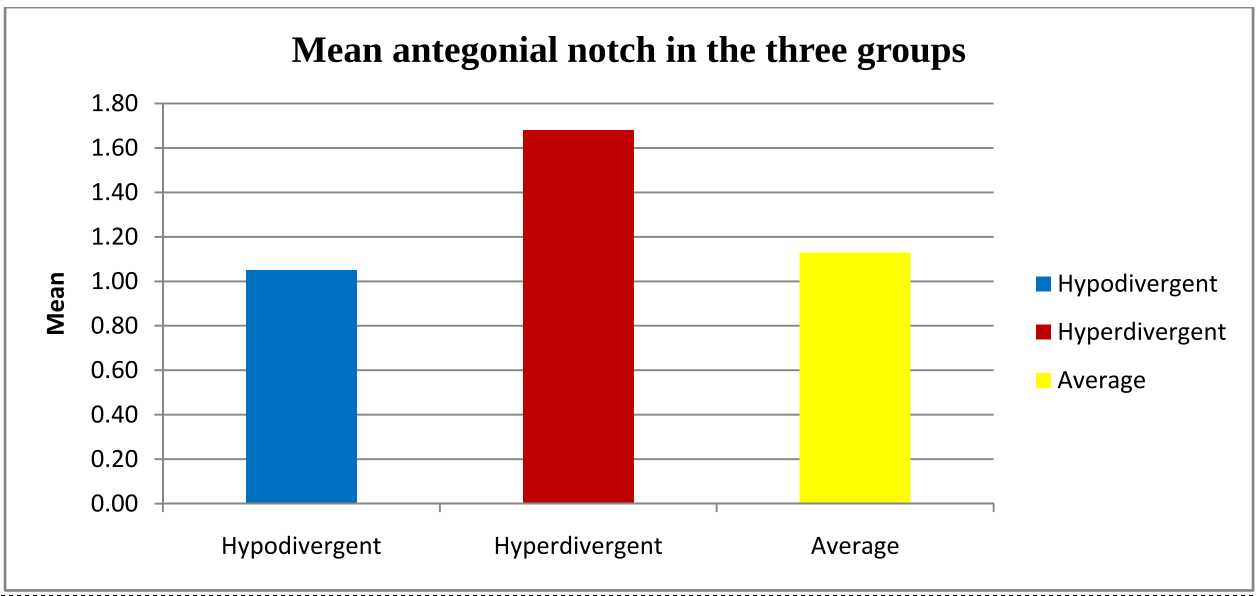
ANALYSIS OF ANTEGONIAL NOTCH:

TABLE -3

Group	Mean	Std dev	Min	Max	Kruskal-Wallis Chi-sq	P-Value
(i) Hypodivergent	1.05mm	1.01mm	0.58mm	1.52mm	4.029	0.133
(ii) Hyperdivergent	1.68mm	.99mm	1.21mm	2.14mm		
(iii) Average	1.13mm	1.09mm	0.62mm	1.63mm		

Higher mean antegonial notch was observed in hyper divergent group followed by average group and hypodivergent group respectively. The difference in mean antegonial notch between the three groups was not statistically significant (P>0.05).

GRAPH - 3



ANALYSIS OF SYMPHYSIS INCLINATION (degrees):

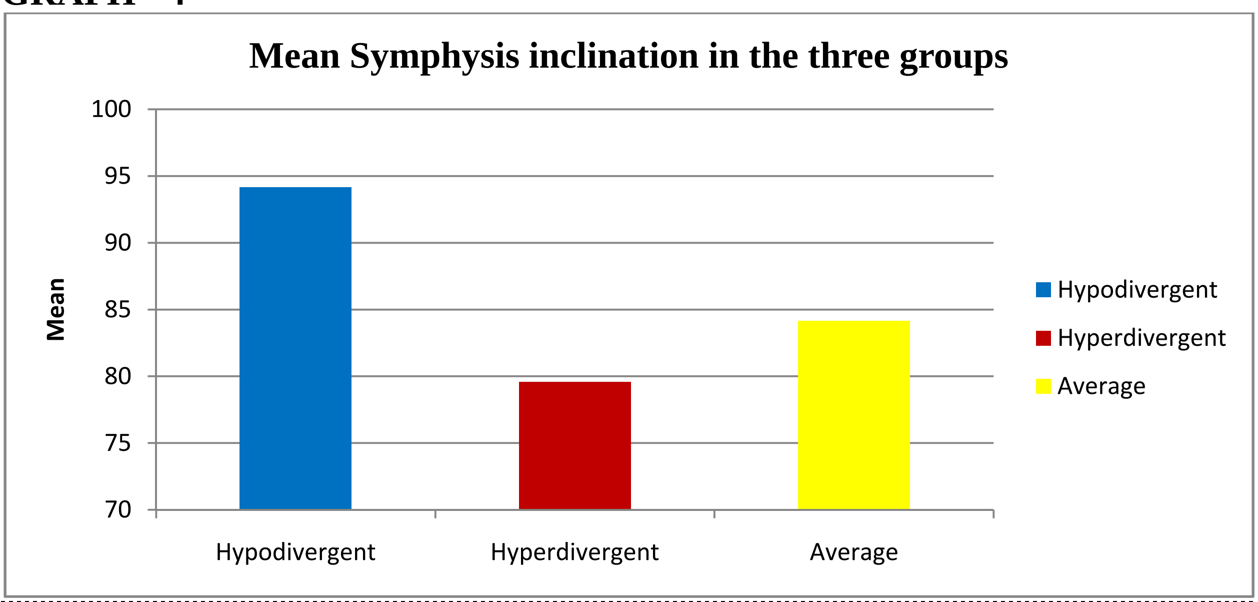
TABLE 4

Group	Mean	Std dev	Min	Max	F	P-Value	Significantly different from
(i) Hypodivergent	94.15°	7.37°	84°	115°	23.798	<0.001*	ii, iii
(ii)Hyperdivergent	79.60°	6.75°	67°	92°			I
(iii) Average	84.15°	6.31°	70°	96°			I

*denotes significant difference

Higher mean symphysis inclination was observed in hypodivergent group followed by average and hyperdivergent group respectively. The difference in mean symphysis inclination between the three groups was found to be statistically significant (P<0.001). The difference in mean symphysis inclination between hypodivergent and hyperdivergent group as well as hypodivergent and average group was found to be statistically significant. No statistically significant difference was observed between average group and hyperdivergent groups.

GRAPH - 4



ANALYSIS OF SYMPHYSIS INCLINATION (mm):

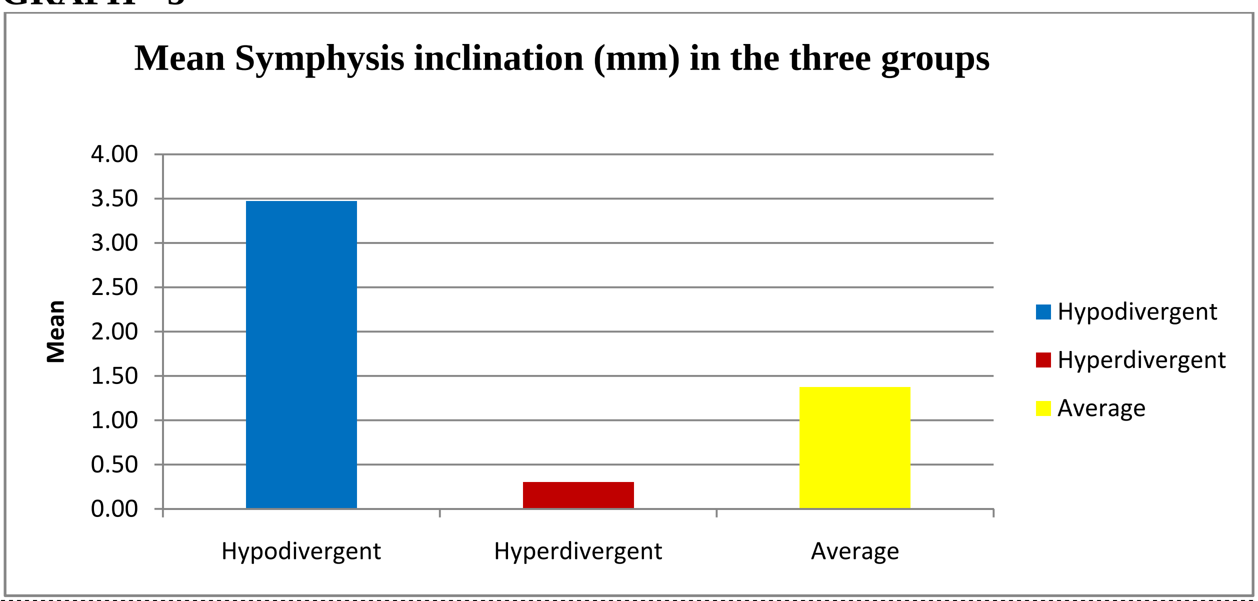
TABLE - 5

Group	Mean	Std dev	Min	Max	F	P-Value	Significantly different from
(i)Hypodivergent	3.48mm	1.34mm	1.0mm	6.0mm	29.617	<0.001*	ii, iii
(ii)Hyperdivergent	0.30mm	1.39mm	-3.0mm	2.5mm			i,iii
(iii) Average	1.38mm	1.24mm	-2.0mm	4.0mm			i, ii

*denotes significant difference

Higher mean symphysis inclination was observed in hypodivergent group followed by average and hyperdivergent group respectively. The difference in mean symphysis inclination between the three groups was found to be statistically significant (P<0.001). The difference in mean symphysis inclination between hypodivergent and hyperdivergent group as well as between hypodivergent & average group was found to be statistically significant. Also, the difference in mean symphysis between hyperdivergent and average group was also found to be statistically significant.

GRAPH - 5



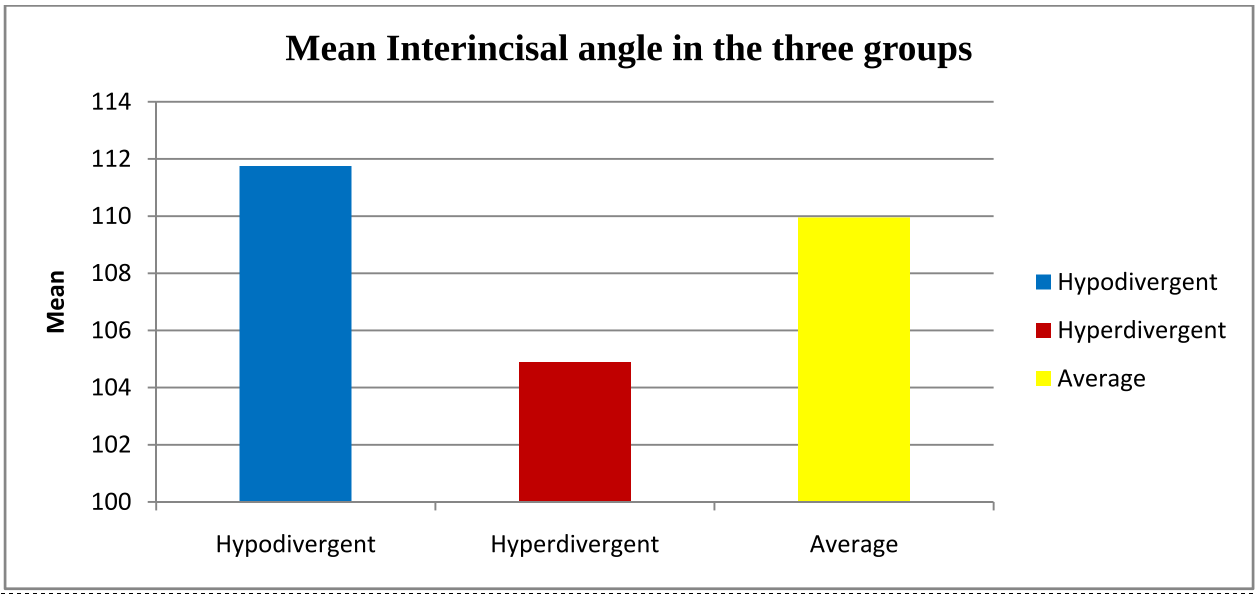
ANALYSIS OF INTERINCISAL ANGLE:

TABLE - 6

Group	Mean	Std dev	Min	Max	F	P-Value
(i) Hypodivergent	111.75°	10.80°	90°	132°	1.865	0.164
(ii)Hyperdivergent	104.90°	12.94°	82°	130°		
(iii) Average	109.95°	11.03°	86°	133°		

Higher mean interincisal angle was observed in hypodivergent group followed by average and hyperdivergent group respectively. The difference in mean interincisal angle between the three groups was not statistically significant (P>0.05).

GRAPH 6



ANALYSIS OF INTERMOLAR ANGLE:

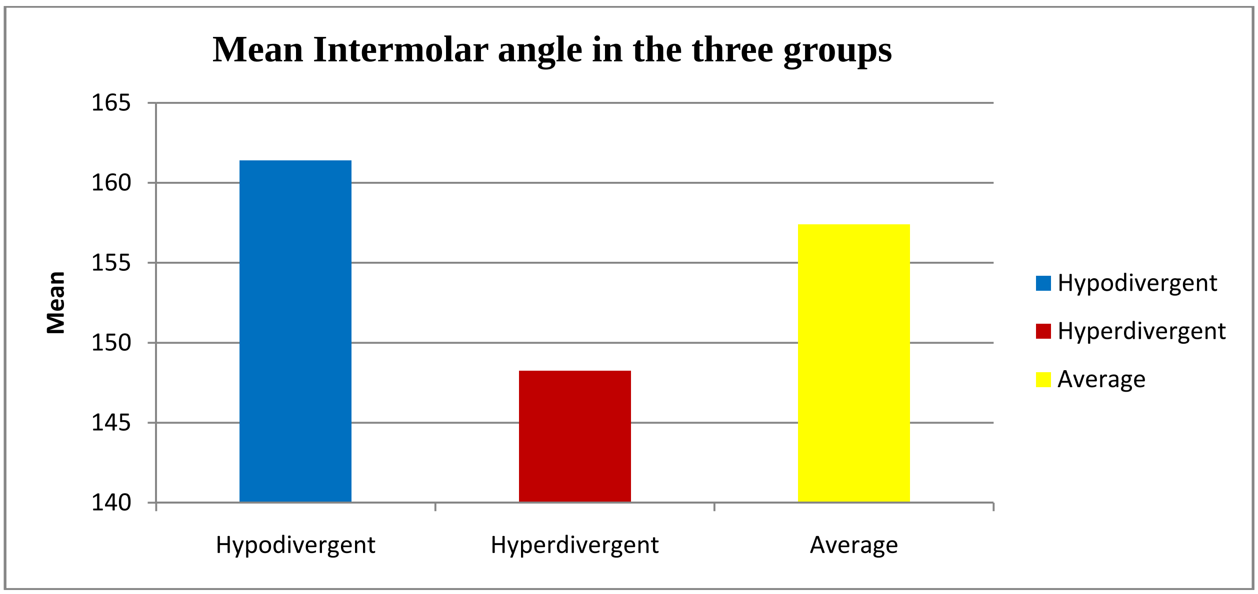
TABLE - 7

Group	Mean	Std dev	Min	Max	F	P-Value	Significantly different from
(i) Hypodivergent	161.40°	4.02°	152°	166°	48.173	<0.001*	ii, iii
(ii)Hyperdivergent	148.25°	5.65°	136°	160°			i, iii
(iii) Average	157.40°	2.93°	152°	163°			ii, iii

*denotes significant difference

Higher mean intermolar angle was observed in hypodivergent group followed by average and hyperdivergent group respectively. The difference in mean intermolar angle between the three groups was found to be statistically significant (P<0.001). The difference in mean intermolar angle between hypodivergent and hyperdivergent group as well as between hypodivergent & average group was found to be statistically significant. Also, the difference in mean intermolar angle between hyperdivergent and average group was also found to be statistically significant.

GRAPH - 7



ANALYSIS OF INTER PREMOLAR ANGLE:

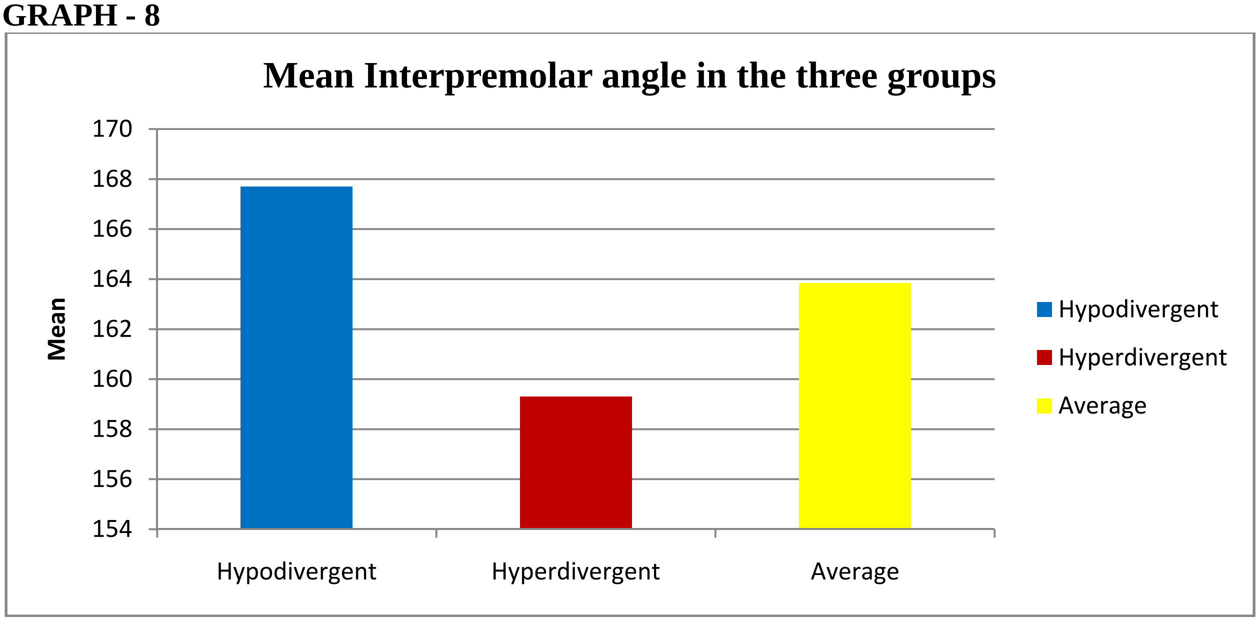
TABLE-8

Group	Mean	Std dev	Min	Max	F	P-Value	Significantly different from
(i) Hypodivergent	167.70°	5.57°	157°	175°	8.962	<0.001*	Ii
(ii)Hyperdivergent	159.30°	8.05°	140°	176°			I
(iii) Average	163.85°	4.75°	155°	176°			

*denotes significant difference

Higher mean interpremolar angle was observed in hypodivergent group followed by average and hyperdivergent group respectively. The difference in mean interpremolar angle between the three groups was found to be statistically significant (P<0.001). The difference in mean interpremoalr angle between hypodivergent and hyperdivergent group was found to be statistically significant. No statistically significant difference was observed between average group and the other groups.

GRAPH - 8



ANALYSIS OF ANTERIOR LOWER FACIAL HEIGHT (ALFH):

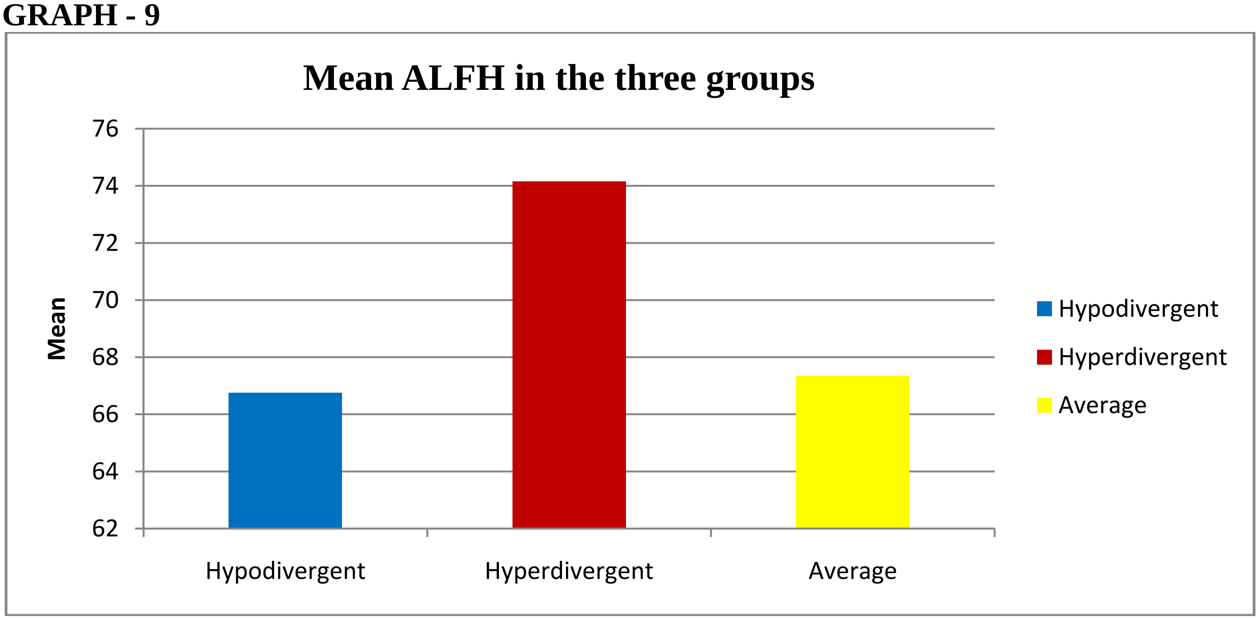
TABLE -9

Group	Mean	Std dev	Min	Max	F	P-Value	Significantly different from
(i) Hypodivergent	66.75mm	4.79mm	57mm	77mm	8.871	<0.001*	Ii
(ii)Hyperdivergent	74.15mm	7.77mm	55mm	89mm			i, iii
(iii) Average	67.35mm	5.56mm	57mm	82mm			Ii

*denotes significant difference

Higher mean ALFH was observed in hyperdivergent group followed by average and hypodivergent group respectively. The difference in mean ALFH between the three groups was found to be statistically significant (P<0.001). The difference in mean ALFH between hypodivergent and hyperdivergent group was found to be statistically significant. Also, the difference in mean ALFH between hyperdivergent and average group was also found to be statistically significant. No statistically significant difference was observed between hypodivergent and average group with respect to the mean ALFH.

GRAPH - 9



DISCUSSION

Diagnosis and treatment of malocclusion depends on the form and growth of the human face. The interplay of vertical growth as related to anteroposterior growth is responsible for various facial types. The various descriptions of facial types, such as hyperdivergent, hypodivergent and average, are related to structural variations and interactions between vertical and anteroposterior growth.

Extensive knowledge of facial morphology and development is necessary for the successful treatment of dentofacial deformities.

Orthodontist must understand and appreciate the value of vertical growth and also must constantly seek a deeper understanding into how the growth in this direction produces different facial types.

Bjork's structural signs of mandibular growth rotation by **Pancherz** [50] et al assessed the hypodivergency and hyperdivergency of mandible, which showed hypodivergency, was more easily appreciable than hyperdivergency.

The present study was aimed to seek compare the morphological changes in mandible between hypodivergent, hyperdivergent and average growth patterns using Bjork's seven signs of mandibular rotation.

This cephalometric study of mandible in average, hypodivergent and hyperdivergent patterns was based on 60 adult subjects within the age group of 18 years and above. None of them had previous history of orthodontic treatment. The subjects were divided into 3 groups of 20 each.

- Hypodivergent group with SN-GoGn angle less than 28degrees.
- Average group with SN-GoGn angle between 28-32degrees.
- Hyperdivergent group with SN-GoGn angle greater than 32 degrees.

Various cephalometric points, planes, linear and angular measurements were used in the study to evaluate the morphological changes of mandible in each group. **Bjork**[12]seven signs of mandibular rotation i.e. Inclination of condylar head, inferior border of mandible, inclination of symphysis, interincisal angle, intermolar angle and curvature of mandibular canal and anterior lower facial height were used for the analysis.

Among all these seven parameters, curvature of mandibular canal could only be differentiated visually as accurate measurement were not possible, since specific cephalometric landmarks could not be established. This parameter was excluded from the study.

The interpretation of information gained by cephalometric measurements clearly showed morphological changes between groups. Seven structural signs of extreme rotation would be considered in relation to the condylar growth direction. An individual will not have all the signs towards a particular growth rotation however inference was based on majority of indicators.

MANDIBULAR PLANE ANGLE (SN-MP)

In this study, mandibular plane angle was measured between the SN (Sella – Nasion) plane and to the mandibular plane (Gonion – Menton) (fig 3) as taken by **Schudy**[8]

Higher mean mandibular plane angle was observed in hyperdivergent group (38.25°) followed by average (30.50°) and hypodivergent (24.60°) group respectively. The difference in mean values between the three groups was found to be statistically significant ($p<0.001$).The difference in mean values of hypodivergent and hyperdivergent group as well as between hypodivergent& average group was found to be statistically significant. Also, the difference in mean values between hyperdivergent and average groups were observed. Similar results were also reported by Dorthe **betgenberger**[47]**, Gail burke**[44]**, and Clifford singer**[43].

INCLINATION OF CONDYLAR HEAD

Condylar head inclination was measured as the angle between a line representing anterior cant of the condylar head and a line perpendicular to the FH plane extending on to the condylar head (fig 3).According to **Bjork**[12] appreciation of condylar head on conventional lateral cephalograms were difficult. In this study the reference was taken from study done on condylar head by **Gail burke** [44]

Results obtained indicated that, condylar head inclination was statistically significant [$p<0.001$], between the groups. higher mean condylar inclination observed in hypodivergent 11.50° group, followed by average and 7.90° and hyperdivergent 6.20°group respectively. The difference in mean condylar inclination between the three groups was found to be statistically significant ($p<0.001$). The difference in mean condylar inclination between hypodivergent and hyperdivergent group as well as between hypodivergent &average group was found to be statistically significant. Also the difference in mean condylar inclination between hyperdivergent and average group was also found to be statistically significant.

Our results were in accordance with the results of **Gail burke**[44]**.**

INFERIOR BORDER OF MANDIBLE (ANTEGONIAL NOTCH)

This linear measurement was taken from greatest point of convexity in antegonial notch to line connecting anterior convexity point (ACP) with inferior gonion (IGo) (fig 4) as taken by **Ronald .p.kolodzeij**[50]**.**

According to the studies by **Ronald p kolodziej**[50]**. Tor karlsen**[41] **lambrechts**[42]**; Singer** [43]**;** Enlow have proved that in a horizontally growing patient, the mandibular border is almost flat. In vertically growing patient, because of the backward rotation of mandible, and the Masseter muscle pull, the antegonial notch gets deepened giving the lower border of mandible a notched appearance.

According to this study, higher mean antegonial notch was observed in hyperdivergent group followed by average and hypodivergent group respectively.

It was noticed that hypodivergent patterns have almost a flat inferior mandibular border but in hyperdivergent, the notching of the inferior border is seen.

INCLINATION OF SYMPHYSIS

The inclination of symphysis was measured as both angular and linear values.

The angle was measured between SN plane to line connecting B, Pog, as taken by **Bjork**[26] and the linear distance was measured between perpendicular lines drawn from B & Pog to true horizontal plane (SN^1) (fig 3) as taken by **Tor karlsen**[41].

The results have shown higher mean symphysis inclination observed in hypodivergent group 94.15°fallowed by average 84.15° and hyperdivergent 79.60° group respectively. Linear Symphysis inclination results showed higher mean inclination observed in hypodivergent group 3.48mm followed by average 1.38mm and hyperdivergent 0.30mm respectively

The difference in mean symphysis inclination between the three groups was found to be statistically significant ($p<0.001$). The difference in mean symphysis inclination between hypodivergent and hyperdivergent group as well as hypodivergent and average group was found to be statistically significant. No statistically significant difference was observed between average group and hyperdivergent groups.

The horizontal and vertical components of the chin increases in size as mandibular basal arch form varies from tapered in vertical growers to more square in horizontal growers.

According to previous studies, **Haskell**[22] had suggested that with vertical development of the mandible, a smaller proportion of protruding chin is present.

It could be interpreted that forward rotating patterns of growth allows pogonion to move in a relatively forward direction resulting in a prominent chin point. Backward rotating mandibles move pogonion backwards and downwards producing a less prominent chin.

In a study by **Nanda**[40], symphyseal morphology was compared to the dental classification of the molars. He concluded that the chin button was not found to belong to any particular classification of dental occlusion, and was, therefore the result of hereditary potential rather than a functional use or disuse mechanism.

According to this study significant symphysis inclination variations were observed in all the three patterns.

INTERINCISAL ANGLE

Angle between the lines drawn along the long axis of upper and lower incisors. (fig 3)

As according to the data obtained, higher mean interincisal angle was observed in hypodivergent group (111.75°), followed by average (109.95°) and hyperdivergent group (104.90°) respectively. The difference in mean interincisal angle between the three groups was not statistically significant ($p>0.05$)

Even though there is no statistically significant difference between the groups, vertical growth pattern shows more acute angle in as compared to horizontal growth pattern. This was probably due to the upper and lower incisors having a more mesial inclination in hyperdivergent group than in the hypodivergent pattern which was also in concurrence with findings of **Bjork**[12]**.**

These values could have been influenced if habits were taken into consideration as they were not considered in this study.

INTERMOLAR ANGLE

Inter molar angle was measured between the perpendicular lines drawn from mandibular plane to lower 1st molar mesio buccal cusp tip and palatal plane to mesio buccal cusp tip of upper 1st molar. (Fig 3)

Usually the long axis of the molars are taken to measure the intermolar angle but in present study it was difficult to locate them, so the mesio buccal cusp tips were taken as the reference points and were used to measure intermolar angle.

In this study, higher mean intermolar angle was observed in hypodivergent group (161.40°) followed by average (157.40°) and hyperdivergent (148.25°) respectively.

The difference in mean intermolar angle between the three groups was found to be statistically significant ($p<0.001$). The differences in mean intermolar angle between hypodivergent & hyperdivergent group as well as between hypodivergent & average group was found to be statistically significant. Also the difference in mean intermolar angle between hyperdivergent and average group was also found to be statistically significant.

The backward rotation of mandible lead to smaller intermolar angle. Therefore mandibular molars are inclined forwards in relation to the maxillary ones to a pronounced degree, because of close proximity of these teeth to the centre of rotation. This was also proved by **Bjork**[12]

INTERPREMOLAR ANGLE

In this study the interpremolar angle was measured between the lines drawn along the long axis of upper and lower 2nd premolars. (Fig 3)

Locating the long axis of premolars were more accurate compared to the long axis of molars.

Higher mean interpremolar angle was observed in hypodivergent (167.70°) fallowed by average (163.85°) and hyperdivergent group (159.30 °) respectively. The difference in mean interpremolar angle between the three groups was found to be statistically significant ($p<0.001$). The difference in mean interpremolar angle between hypodivergent and hyperdivergent group was found to be statistically significant. No statistically significant difference was observed between average group and other groups.

The backward rotation of mandible lead to smaller interpremolar angles. This indicates that the mandibular premolars are inclined forwards in relation to the maxillary premolars. This was also proved by **Bjork**[12].

ANTERIOR LOWER FACIAL HEIGHT (ALFH)

ALFH was measured as the distance between anterior nasal spine (ANS), and Menton (Me) (fig 4)[56]

As according to this study, higher mean ALFH was observed in hyperdivergent group (74.15mm), followed by average (67.35mm) and hypodivergent group respectively. The difference in mean ALFH between 3groups was statistically significant ($p<0.001$). The difference in mean ALFH between hypodivergent and hyperdivergent group was found to be statistically significant. Also the difference in mean ALFH between hyperdivergent and average group was also found to be statistically significant. No statistically significant difference was observed between hypodivergent and average group with respect to the mean ALFH

According to the previous studies**, Opdebeeck[20]; Harris[41]; Herbert[52]; Fields[27]** have suggested that vertical patterns have an increased lower anterior facial height and horizontal pattern have decreased lower anterior facial height.

Increased lower anterior facial height is due to the backward rotation of mandible, where maxilla also descends down to counteract for the mandibular growth.

Hyperdivergent patient's exhibit increased lower anterior facial height and hypodivergent patients having decreased lower anterior facial height

The results of this study was in accordance to the previous studies, showing a statistically significant value between the groups with $p<0.001$.

Increased lower facial heights results in a high level of mentalis muscle activity in order to raise the lower lip for a lip seal. Short lower facial heights produce a curl of the lower lip.

Bjork stated that people who have long anterior facial heights are backward rotators.

Opdebeeck [21]et al suggested that long face syndrome was attributed to clockwise rotation of mandible and short face syndrome attributed to counterclockwise rotation of mandible.

An anterior or posterior condylar position within the fossa may have a direct effect on the anteroposterior and vertical position of mandible. This in turn could have a direct effect on facial morphology.

Posterior rotation of the condyles has been shown to dominate in individuals with the classic long face syndrome, and anterior inclination of the condylar head can be associated with counter clock-wise mandibular rotations. It was also reported that reduced condylar growth represents clock-wise rotators of mandible in relation to the cranial base.

The proliferation of condylar cartilage and endochondral ossification of condyle occurs via complex biomechanical interactions. The magnitude, direction and duration of the resultant condylar growth may be influenced by genetic determinants as well as intrinsic and extrinsic control factors.

Decreased superior joint spaces were consistent with class II individuals in hyperdivergent tendency. Increased superior joints spaces were also consistent with class II individuals in the hypodivergent group. This suggests that patients who exhibit a vertical facial pattern may reflect a reduction in condylar soft tissue. Patients who exhibit reduced condylar tissues could represent reduced growth potential, minimal distraction within the glenoid fossa, and therefore reduced superior joint spaces. It is also documented that there is a relationship between superior joint space and condylar head inclination with horizontal and vertical facial morphology in preadolescent patients.

The distinction between forward and backward growers was based on the direction of the true rotation. A forward grower, besides presenting a forward true rotation also, presents low gonial angles, no antegonial notches, a good chin projection, high coronoid processes, condyles growing up and forward and strong facial musculature.

In contrary, the backward grower presents a backward true rotation, high gonial angles, evident antegonial notches, lack of chin projection, skinny coronoid processes, condyles growing up and back and weak muscles. True rotation has its center depending on apparent and remodeling rotations. Apparent rotation has its center at the condyles and remodeling rotation has its center at the mandibular corpus

The hyperdivergent skeletal pattern presents poor muscle activity with lower minimum bite force than the hypodivergent pattern in both children and adults. Both the quantity and biological quality of the masseter muscles is different in bite groups with different vertical dimensions.

Gionhaku and **Lowe**[29] reported that subjects with large masseter and medial pterygoid muscle volumes had flat mandibular and occlusal planes, and a small gonial angle, which are characteristic features of hypodivergent patients

The forward inclination of the condylar head was associated with forward mandibular rotators, along with a greater curvature of mandibular canal than the mandibular contour.

A tendency towards backward rotation is associated with a pronounced apposition below the symphysis with more overall concavity of the lower mandibular border. An inclination of the symphysis with proclination is an indicator of a backward rotating mandible.

Bjork examined children with and without malocclusion and also children with pathologic conditions by means of the implant studies; he described two different types of mandibular condylar growth— forward and backward. The expression of this condylar growth is influenced by the location of the center of rotation of the mandible whether it is at the incisors, premolars, or the condyle.

Previous studies[38, 12] have reported conflicting results with respect to the effect of sex differences on mandibular shape. In measuring the gonial angle, some investigators reported no difference between sexes whereas others found a larger gonial angle in the female subjects. Male subjects have a tendency toward a smaller gonial angle and a more rounded mandible

A study of the relationship between facial types [hypodivergent vs. hyperdivergent pattern] and bone thickness related that bone morphology is related to masticatory function and that bone morphology is related to masticatory function and that face types are associated with cortical bone thickness in the body of the mandible and buccal inclination of the molars.

The body of the mandible in a short face [hypodivergent] pattern has a thicker cortical bone than that of a long face. Decreased bite force, muscle function and biological efficiency in skeletal hyperdivergent classII malocclusion could lead to smaller volumes of the mandible than those of hypodivergent subjects.

Various extrinsic & intrinsic factors are responsible for various types of mandibular morphologies. A complete understanding of these morphologies both clinically and cephalometrically is essential for orthodontic diagnosis & treatment.

CONCLUSION

As according to our study, using **Bjork** signs for mandibular morphology:

1. Condylar head was inclined more backwardly and more forwardly in hyperdivergent, average and hypodivergent patterns respectively.
2. Inferior border of mandible had a notched appearance in hyperdivergent, average growth and almost flat in hypodivergent patterns.
3. Anterior lower facial height increased in hyperdivergent fallowed by average growth pattern and decreased in hypodivergent patterns.
4. Interincisal, intermolar and inter premolar angles were more mesially inclined in hyperdivergent, average growth pattern than hypodivergent patterns.
5. Symphysis was more forwardly inclined in case of hypodivergent and backwardly inclined in hyperdivergent and average growth patterns.
6. Hypodivergence growth pattern is more easily identified than hyperdivergent and average growth pattern.

THIS STUDY DONE ON LOCAL KOMARAPALAYAM (DIST- NAMAKKAL) POPULATION, RESULTS ARE IN ACCORDANCE WITH THE STUDY DONE BY BJORK

The understanding of craniofacial growth is mandatory to diagnose the problem, to better understand the etiology of the problem and to evaluate pre-treatment and post-treatment changes.

This study was conducted in department of Orthodontics and Dentofacial Orthopedics of J.K.K.NATARAJA Dental College and Hospital, Komarapalayam, Namakkal Dist. For the comparison of mandibular morphology between average, hypodivergent and hyperdivergent growth patterns.

The study was prospective in nature comprising of lateral cephalogram of 60 subjects. The subjects were divided into 3 subgroups average, hypodivergent and hyperdivergent growth pattern. Bjork signs of mandibular rotation were used for analysis.

According to the investigations, there was a significant difference in the mandibular morphology between the groups, Subjects with hypodivergent pattern showed forwardly inclined condylar head, flat inferior mandibular border, and thick symphysis with more forward inclination and more obtuse inter molar, premolar, inter incisal angle.

Hyperdivergent subjects exhibited backwardly inclined condyle, notched inferior mandibular border, symphysis with a backward inclination and a more acute interincisal and intermolar angles.

Average growth pattern subjects showed backwardly inclined condylar head, notched inferior mandibular border, symphysis with a backward inclination and more obtuse inter molar , premolar, inter incisal angle.

Further studies are needed with longitudinal patient sample, tomograms of condyles, including mandibular canal morphology and various factors like growth, habits also need to be consider to establish a cephalometric criteria for better understanding various mandibular morphologies.

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